ADVANCED GeoServices
Engineering for the Environment. Planning for People.™
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www.advancedgeoservices.com

July 21, 2015

2003-1046-35

Ms. Tamara Ohl
United States Environmental Protection Agency – Region 5
77 West Jackson Boulevard
Chicago, IL 60604-3590

RE: Amendment to CMD response to comments
Refined Metals Corporation – Beech Grove, Indiana
IND 000 718 130

Dear Ms. Ohl:

Refined Metals Corporation (RMC) and Advanced GeoServices Corp. (Advanced GeoServices) have reviewed your comments received (via email) on June 26, 2015, pertaining to the condition approval of the Amendments to the Corrective Measures Design (CMD) for the former RMC facility located in Beech Grove, Indiana. These comments were further discussed on a conference call with you on July 1, 2015. All parties agreed that comments should not delay the Explanation of Significant Differences (ESD) process, and that addressing them would be a condition of the ESD. During that call Advanced GeoServices agreed with several of the comments and proposed that this be documented in a response.

The comments (**in bold**) and responses are indicated below.

Comment 1: A review of the Stormwater calculations could not be completed because the drainage areas are inconsistent throughout document and this parameter has an effect on almost all of the calculations. The drainage area of the project site was documented previously as 11.2 acres. Figure DA-02 shows three drainage areas which total 11.2 acres. However, the HydroCAD calculations show four drainage areas which total 10.25 acres. The drainage area used in the water quality volume also does not match DA-02 or the areas used in the HydroCAD calculations. The drainage areas should be consistent in all calculations and match previous project total drainage areas. The HydroCAD calculations refer to a fourth subcatchment, 9S. Provide a revised drainage diagram which includes 9S.

Response: We apologize for any confusion that these discrepancies may have resulted in. Additional review of the calculations and drawings was performed to ensure consistency. Drawing DA-01, Drawing DA-02 and the HydroCAD calculations have been revised to show a total drainage area (existing and proposed) of 11.32 acres. The unmanaged area has been revised from 4.00 acres to be 5.07 acres, which corrects the discrepancy noted between the drainage areas in the June submission. Additionally the water quality calculations and the HydroCAD diagram have been revised. A revised Section 10 of the CMD is provided as a summary of the proposed post-CCB construction conditions. The corrected support documents are attached and include drawings (DA-01 and DA-02), calculation sheets (water quality volume), and the HydroCAD reports.

Comment 2: The overall design has changed due to the addition of the CCB. As-built drawings should be included in the report and the O&M Plan updated accordingly. This also applies to the documents mentioned in Comment 1.

Response: As-built drawings will be included in the completion report and also added to the O&M Plan

Comment 3: The geotextile, HDPE, and geocomposite could be disposed of in the CCB provided RMC employs the following appropriate precautions:

- **When cutting the geocomposite, HDPE, and geotextile ensure adequate overlap for proper shingling and seam welds.**
- **Cut the geotextiles to be discarded into manageable sizes so that they can be adequately compacted with the soils and not placed in the CCB with large folds or voids.**
- **Spread out the geotextiles so that they are not all in one small section of the CCB to ensure slope stability.**
- **Additional puncturing of the HDPE should be performed with hand tools if needed to ensure adequate drainage.**
- **Ensure the compaction specifications in the CMD are met in the materials overlying the discarded materials.**

Response: As discussed during the call on July 1, we agree with this approach and will direct the Contractor to employ these steps during the construction of the CCB.

Comment 4: It is unclear how the anchor trench and drainage piping/permeable material trench already in place on the south end of the existing containment cell will be handled. The eastern and western terminus of this trench should be abandoned and backfilled with low permeability materials so that storm water does not collect in the original southern trench that will now be located below and within the footprint of the CCB.

Response: As discussed during the call on July 1, we generally agree with this approach. The drainage piping on the east and west sides of the cell will be cut before the turn into the existing southern berm. The drainage pipe runs on the east and west sides will be extended around the perimeter of the CCB. The drainage pipe remaining in the existing southern berm will be removed during the re-grading of the southern berm.

Prior to speaking with you on July 1, it was our understanding that a sixty (60) day public comment period would be part of the ESD process. If required, that period could delay work until September. During the July 1 call, you indicated that there would be a public notice issued (coordinated by IDEM), but that a public comment period was not anticipated unless the notification unexpectedly generated a significant level of response/interest. As a result, RMC will strive to resume the CMI work as soon as possible. RMC is working through contracting negotiations with the remedial contractor (Op-Tech), but is targeting a date of August 17 to mobilize and resume work.

If you have additional questions, please do not hesitate to contact the undersigned at (610) 840-9136.

Sincerely,

ADVANCED GEOSERVICES

Jan S. Dobinsky
Senior ~~Project~~ Professional

Paul G. Stratman, P.E., P.G.
Consultant

PAUL G. STRATMAN REGISTERED No. 19400366 STATE OF INDIANA PROFESSIONAL ENGINEER

7/24/

JSD:PGS:vm

Enclosures

cc: Matt Love, RMC
Ruth Jean, IDEM
Sandy Anagnostopoulos, TetraTech

10.0 POST CORRECTIVE MEASURES STORM WATER MANAGEMENT

Post corrective measures storm water management has been designed to comply with the *City of Indianapolis Stormwater Specifications Manual.* Section 302.03 of that document indicates that an increase in run-off volume is acceptable provided that sufficient detention/retention is provided to reduce the runoff flow (discharge rate). The required detention is as follows:

- 2-yr storm: $Q_{2proposed} \leq 0.5\ Q_{2existing}$
- 10-yr storm: $Q_{10proposed} \leq 0.5\ Q_{10existing}$
- 25-yr storm: $Q_{25proposed} \leq 0.75\ Q_{10existing}$
- 100-yr storm: $Q_{100proposed} \leq\ Q_{10existing}$

A comparison of existing and proposed conditions (based on 1-hr storm duration) is provided in the following table:

Condition	**Existing, $_e$**	**Proposed, $_p$**	**Difference**
Runoff Area (acre)	11.32	11.32	0.00%
Pervious Area (acre)	5.89	10.45	177%
Impervious Area (acre)	5.43	0.87	16%
V_2 2-yr Runoff Volume (acre-ft)	0.38	0.36	95%
Q_2 2-yr Runoff Flow (cfs)	8.6	4.06	47%
V_{10} 10-yr Runoff Volume (acre-ft)	0.87	0.84	97%
Q_{10} 10-yr Runoff Flow (cfs)	20.2	8.40	42%
V_{25} 25-yr Runoff Volume (acre-ft)	1.14	1.10	97%
Q_{25} 25-yr Runoff Flow (cfs)	27.2	10.43	38%
V_{100} 100-yr Runoff Volume (acre-ft)	1.59	1.55	97%
Q_{100} 100-yr Runoff Flow (cfs)	39.2	13.45	34%

The run-off area for the proposed conditions does not change significantly from the existing conditions. However, the proposed conditions indicate a significant reduction in impervious area. Supplemental drawing DA-01 depicts the existing runoff area; DA-02 depicts the proposed runoff area. HydroCAD results indicate that proposed run-off volume will be slightly lower than the existing conditions, but the basins and other stormwater management features provide more than adequate retention to satisfy the requirements of the City of Indianapolis.

As shown on Sheets 9 and 10, the post corrective measures storm water management will consist of a gravity storm water system that will convey storm water runoff from the former impervious manufacturing areas of the site and the southern and eastern portion of the proposed containment cell cap through storm water management basins situated along the south and east sides of the proposed containment cell. Pipe profiles and construction details are provided on Sheets 11 and 12.

The south storm water management basin (Basin 1) will cover approximately 1.4 acres and have a maximum storage capacity of approximately 93,677 cubic feet before reaching the emergency spillway. The calculated storage volume for the 100 year design storm event is approximately 9,839 cubic feet. The outlet structure will be an 18-inch diameter corrugated polyethylene pipe with an invert elevation of 840.30 that discharges to the east storm water management basin (Basin 2).

Runoff from the eastern portion of the Site enters the sediment forebay and pocket wetland prior to discharge to Basin 2. The pocket wetland will cover a surface area of approximately 38,379 sf. The outlet structure for the pocket wetland will be an 8-inch diameter CPE pipe. Basin 2 will cover approximately 0.2 acres and have a maximum storage capacity of approximately 26,266 cubic feet before reaching the emergency spillway. The calculated storage volume for the 100 year design storm event is approximately 11,731 cubic feet. The primary outlet device for Basin 2 will be a 15-inch diameter pipe that discharges to a wetland mitigation area within a swale conveying flow to the existing drainage channel. The wetland mitigation area is approximately 7,000 sf. The proposed discharge towards the north coincides with the original storm water discharge for the manufacturing areas of the site prior to construction of the storm water collection and treatment system.

Grading and underdrains will convey the storm water runoff from the restored areas of the site to the storm water management basins, as shown on Sheet 9. The total drainage area to the basins is 11.32 acres with an average CN value of 90. HydroCAD® was utilized to perform the storm water management calculations following the SCS TR-20 Method. As presented on the calculations (Attachment C), the south basin (Basin 1) will detain a 1-hrstorm event and attenuate the flows as follows:

DESIGN STORM RETURN	INFLOW (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	STORAGE (cf)
2	3.57	2.44	841.18	806
10	8.13	4.27	841.55	3,909
25	10.64	5.11	841.71	5,945
100	14.93	6.32	841.95	9,839

The east basin (Basin 2) will detain a 1-hr storm event and attenuate the flows as follows:

DESIGN STORM RETURN	INFLOW (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	STORAGE (cf)
2	2.77	2.22	839.57	4,144
10	5.32	4.37	840.06	7,284
25	6.51	5.13	840.32	8,975
100	8.12	6.37	840.71	11,731

CORRECTED WORKSHEET
BASIN WATER QUALITY

ADVANCED GeoServices Engineering for the Environment. Planning for People.™ 1055 Andrew Drive, Suite A - West Chester, PA 19380 (610) 840-9100 - Fax (610) 840-9199	PROJECT: RMC Beech Grove	
	SUBJECT: Water Quality Volume and Pocket Wetland Design	
	SHEET: 1 OF 1	DATE: 11/19/2012
	BY: DJS	REVISED 6/12/2015
	CHK'D: PGS	20031046

$$WQv = \frac{P*Rv*A}{12}$$

P= Rainfall Amount (Inches)
Rv= 0.05+0.009*Impervious Cover
I= % Impervious Cover

Area to Basin 1

I= 18.8 %
Rv= 0.22
A= 3.92 Acres
WQv= 0.07 Acre-Ft
WQv= 3,119 cuft

Area to Basin 2

I= 2.36 %
Rv= 0.07
A= 0.59 Acres
WQv= 0 Acre-Ft
WQv= 152 cuft

Total Requrired WQv= 3,272 cuft
WQv Provided= 4,347 cuft at elevation 840.75

Water Balance

S=Qi+R+Inf-Qo-ET

S= net change in storage
Qi= stormwater runoff inflow
R= contribution from rainfall
Inf= net infiltration
Qo= surface outflow
ET= evapotranspiration

(from Report of Investigation 57: Monthly Lake Evaporation in Inches at Indianapolis for July from 1911 to 1962 is 5.46 inches)

S=footprint of basin x evaporation rate
S= (2,768 sf)x(5.46 in/12 in)
S= 1,259 cuft **Proposed Permanent Storage= 3,088 cuft**

Minimum Wetland Surface Area

A=1.5% of Total Drainage Area*
A= 0.07 acres
A= 2,947 sf **Provided= 4,407 sf**

Minimum Forebay Sizing

V=10% of Wetland Volume
V= 435 cuft **Volume Provided= 1,014 cuft**

*Per 702.02.5 of City of Indianapolis Stormwater Specifications Manual for Shallow Marsh Design

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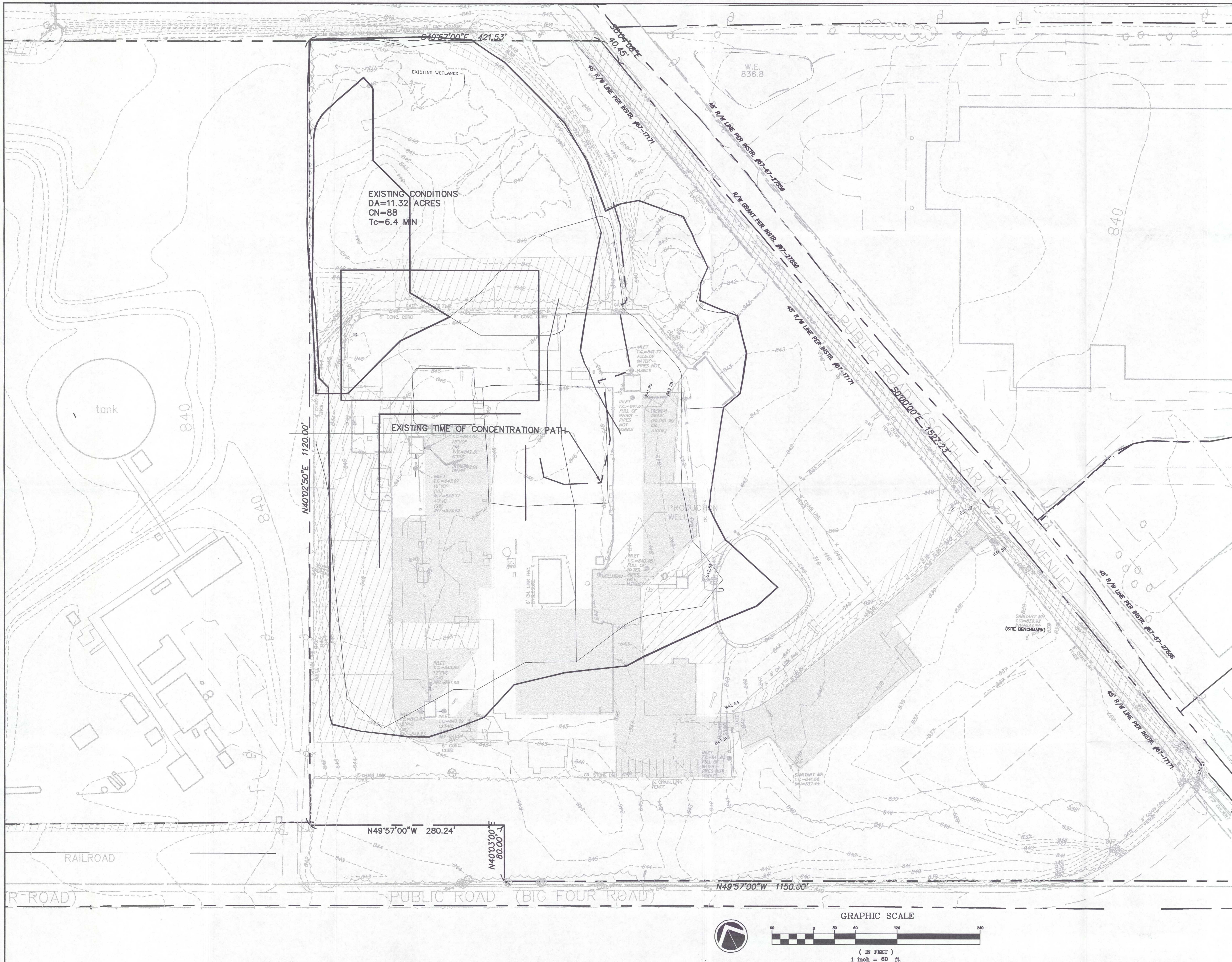
7/29/15

CORRECTED DRAWINGS
DA-01 and DA-02



DATE:	REVISION:
06-30-11	REV. PER 06-20-11 INDIANAPOLIS REVIEW LETTER
08-04-11	REV. TO FINAL
11-20-12	REVISE CAP LAYOUT
6-12-13	REVISE STORMWATER MANAGEMENT BMP'S
7-19-13	REV. PER 06-27-13 INDIANAPOLIS REVIEW LETTER
2-12-14	REV. PER 1-16-14 EPA REVIEW LETTER
07-10-15	REVISED FOR CAP EXPANSION

LEGEND

Proposed Time of Concentration
Proposed Drainage Area
Existing Contour
Existing Building
Former Building Footprint
Existing Edge of Paving
Existing Right of Way
Existing Tree Line
Existing Wetland Limit Line
Existing Flood Plain Limit Line
Existing Lot Line
Property Line (Approximate)
Existing Sanitary Sewer
Existing Stormwater Line w/ Inlet
Existing Water Line
Existing Gas Line
Existing Electric Line
Existing Utility Pole
Approximate Zoning Boundary
Non-HWMU Excavation Area with Excavation Depth in Inches
Proposed Security Fence
MW-11 Monitoring Well
CSB30 Approximate Soil Sample Location
CSB26 Soil Sample Location/Designation Surveyed by the Schneider Corp., Indianapolis, Indiana
RSB77 Soil Sample Location/Designation Surveyed by the Schneider Corp., Indianapolis, Indiana
R2SB25 Phase II RFI Soil Sampling
R2SED1R Sediment Sample Location S. Arlington Ave. Drainage Ditch
RSB8 Sediment Sample Location S. Arlington Ave. Drainage Ditch
RSED3 Sediment Sample Location in Grassy Area Swales
Existing Impervious Surface to Remain

NOTES:

1. TOPOGRAPHIC SURVEY WITHIN REFINED METALS PROPERTY OBTAINED FROM FIELD SURVEY PERFORMED BY THE SCHNEIDER CORPORATION AUGUST, 2010. ORIGINATING BENCHMARK INDIANA DEPARTMENT OF TRANSPORTATION BRONZE DISC STAMPED "MAR G-354" ELEVATION 862.49 (NGVD 29).

2. TOPOGRAPHIC INFORMATION OUTSIDE OF REFINED METALS PROPERTY OBTAINED FROM IMAGIS CITY OF INDIANAPOLIS BASED ON NGVD 29.

3. BUILDINGS ON THE REFINED METALS PROPERTY HAVE BEEN DEMOLISHED, EXCEPT PUMP HOUSES #1 THROUGH #4.

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WEST CHESTER, PENNSYLVANIA 19380

REFINED METALS CORPORATION
BEECH GROVE, INDIANA

STORWATER MANAGEMENT DESIGN & STORMWATER POLLUTION PREVENTION PLAN

EXISTING CONDITIONS DRAINAGE AREA PLAN

DA-01

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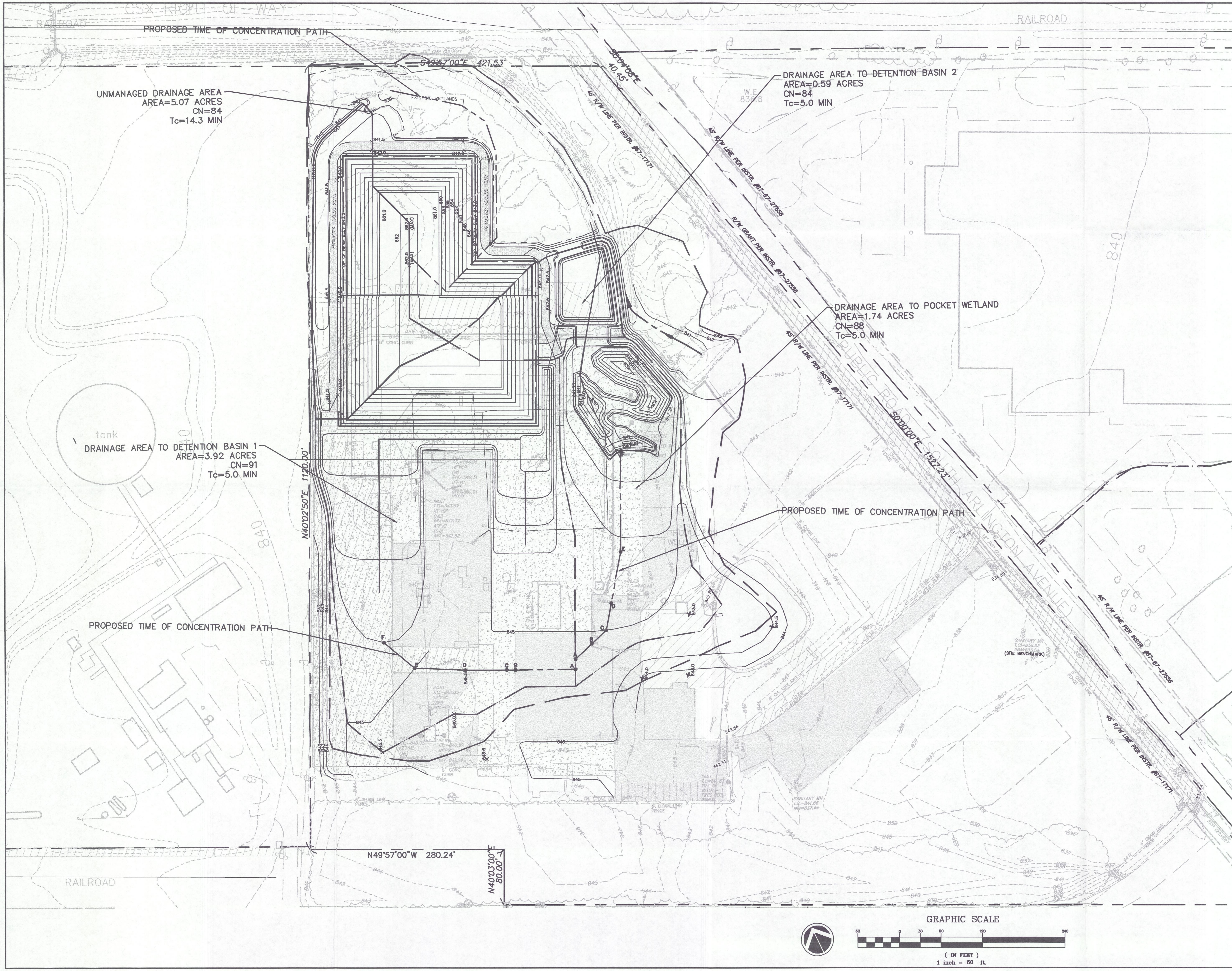
PROFESSIONAL ENGINEER

Scale:	1"=60'
Originated By:	J.W.D.
Drawn By:	P.S.G.
Checked By:	J.W.D.
Project Mgr.:	P.G.S.
Project No.:	2003-1046
Sheet No.:	2 OF 8
Issued:	JUL 21 2015



DATE:	REVISION:
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2-12-14	REV. PER 1-16-14 EPA REVIEW LETTER
07-10-15	REVISED FOR CAP EXPANSION

LEGEND

- Proposed Time of Concentration
- Proposed Drainage Area
- Existing Contour
- Existing Building
- Former Building Footprint
- Existing Edge of Paving
- Existing Right of Way
- Existing Tree Line
- Existing Wetland Limit Line
- Existing Flood Plain Limit Line
- Existing Lot Line
- Property Line (Approximate)
- Existing Sanitary Sewer
- Existing Stormwater Line w/ Inlet
- Existing Water Line
- Existing Gas Line
- Existing Electric Line
- Existing Utility Pole
- Approximate Zoning Boundary
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- RSB77 Soil Sample Location/Designation Surveyed by the Schneider Corp., Indianapolis, Indiana
- R2SB25 Phase II RFI Soil Sampling
- R2SED1R Sediment Sample Location S. Arlington Ave. Drainage Ditch
- RSB8 Sediment Sample Location S. Arlington Ave. Drainage Ditch
- RSED3 Sediment Sample Location in Grassy Area Swales
- Area to be Stabilized with 6" Thick Crushed Stone or Recycled Concrete
- Existing Impervious Surface to Remain

NOTES:

1. TOPOGRAPHIC SURVEY WITHIN REFINED METALS PROPERTY OBTAINED FROM FIELD SURVEY PERFORMED BY THE SCHNEIDER CORPORATION AUGUST, 2010. ORIGINATING BENCHMARK INDIANA DEPARTMENT OF TRANSPORTATION BRONZE DISC STAMPED "MAR G-354" ELEVATION 862.49 (NGVD 29).

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REFINED METALS CORPORATION
BEECH GROVE, INDIANA

STORWATER MANAGEMENT DESIGN &
STORMWATER POLLUTION PREVENTION PLAN

PROPOSED CONDITIONS DRAINAGE AREA PLAN

DA-02

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Scale:	1"=60'
Originated By:	J.W.D.
Drawn By:	P.S.G.
Checked By:	J.W.D.
Project Mgr.:	P.G.S.
Project No.:	2003-1046
Sheet No.:	2 OF 8
Issued:	JUL 21 2015

AMMENDED HYDROCAD 1-HR STORM DISCHARGE REPORT
PROPOSED CONDITIONS

PAUL G. STRATMAN
REGISTERED
No. 19400366
STATE OF
INDIANA
PROFESSIONAL ENGINEER

7/24/15

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 2S: AREA TO BASIN 1	Runoff Area=3.920 ac 18.80% Impervious Runoff Depth=0.54" Tc=5.0 min CN=91 Runoff=3.57 cfs 0.177 af
Subcatchment 3S: AREA TO BASIN 2	Runoff Area=1.738 ac 3.16% Impervious Runoff Depth=0.41" Tc=5.0 min CN=88 Runoff=1.09 cfs 0.059 af
Subcatchment 4S: UNMANAGED AREA	Runoff Area=5.072 ac 1.58% Impervious Runoff Depth=0.27" Tc=14.3 min CN=84 Runoff=1.93 cfs 0.115 af
Subcatchment 9S: AREA TO BASIN 2	Runoff Area=0.589 ac 0.00% Impervious Runoff Depth=0.27" Tc=5.0 min CN=84 Runoff=0.23 cfs 0.013 af
Pond 5P: BASIN 1	Peak Elev=841.18' Storage=806 cf Inflow=3.57 cfs 0.177 af 18.0" x 75.1' Culvert Outflow=2.44 cfs 0.178 af
Pond 6P: POCKET WETLAND	Peak Elev=840.80' Storage=2,297 cf Inflow=1.09 cfs 0.059 af 8.0" x 45.1' Culvert Outflow=0.20 cfs 0.055 af
Pond 7P: BASIN 2	Peak Elev=839.57' Storage=4,144 cf Inflow=2.77 cfs 0.246 af 15.0" x 40.0' Culvert Outflow=2.22 cfs 0.246 af
Link 8L: TOTAL POSTDEVELOPED	Inflow=4.06 cfs 0.361 af Primary=4.06 cfs 0.361 af

Total Runoff Area = 11.319 ac Runoff Volume = 0.365 af Average Runoff Depth = 0.39"
92.30% Pervious = 10.447 ac 7.70% Impervious = 0.872 ac

Summary for Subcatchment 2S: AREA TO BASIN 1

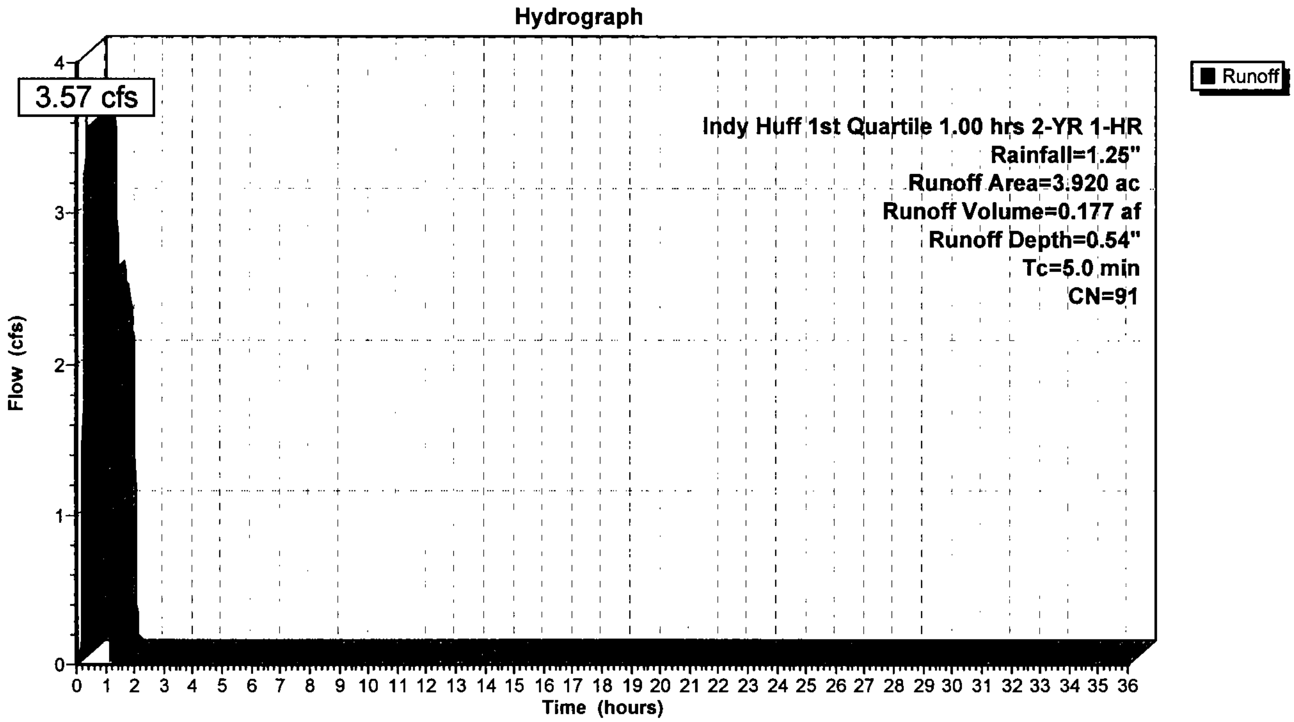
Runoff = 3.57 cfs @ 0.35 hrs, Volume= 0.177 af, Depth= 0.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 2-YR 1-HR Rainfall=1.25"

	Area (ac)	CN	Description
	0.737	98	Paved parking & roofs
	2.629	91	Gravel roads, HSG D
*	0.554	84	50-75% Grass Cover, Fair, HSG D
	3.920	91	Weighted Average
	3.183		Pervious Area
	0.737		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: AREA TO BASIN 1



Summary for Subcatchment 3S: AREA TO BASIN 2

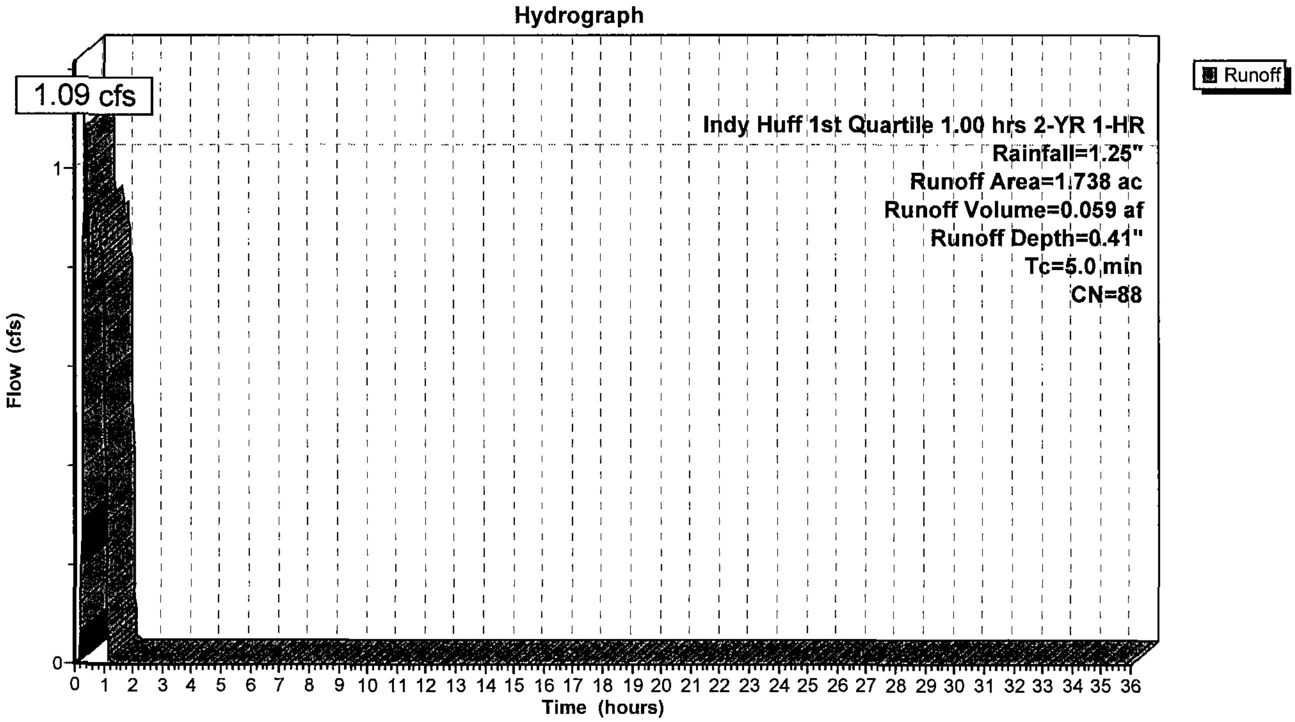
Runoff = 1.09 cfs @ 0.37 hrs, Volume= 0.059 af, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 2-YR 1-HR Rainfall=1.25"

Area (ac)	CN	Description
0.055	98	Paved parking & roofs
0.888	84	50-75% Grass cover, Fair, HSG D
0.795	91	Gravel roads, HSG D
1.738	88	Weighted Average
1.683		Pervious Area
0.055		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: AREA TO BASIN 2



Summary for Subcatchment 4S: UNMANAGED AREA

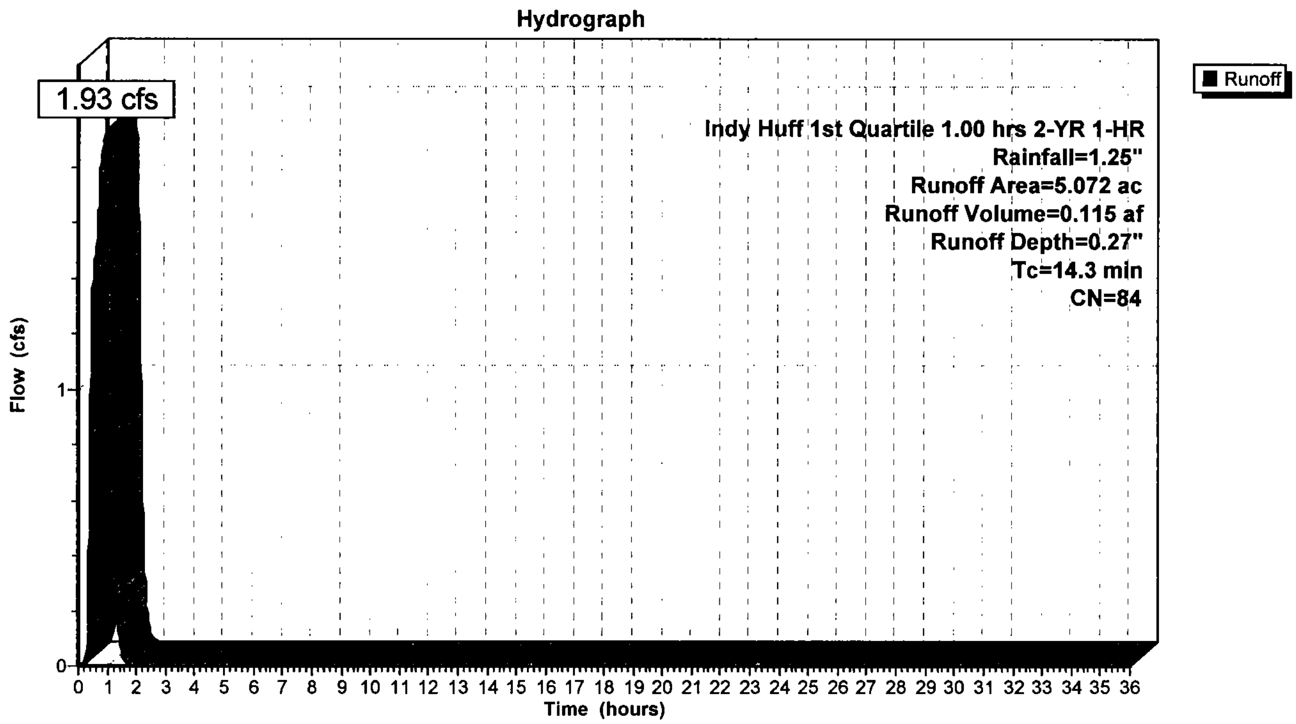
Runoff = 1.93 cfs @ 0.97 hrs, Volume= 0.115 af, Depth= 0.27"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 2-YR 1-HR Rainfall=1.25"

	Area (ac)	CN	Description
	3.435	84	50-75% Grass cover, Fair, HSG D
	0.671	91	Gravel roads, HSG D
	0.886	77	Woods, Good, HSG D
*	0.080	98	Paved Parking & Roads
	5.072	84	Weighted Average
	4.992		Pervious Area
	0.080		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry,**

Subcatchment 4S: UNMANAGED AREA



Summary for Subcatchment 9S: AREA TO BASIN 2

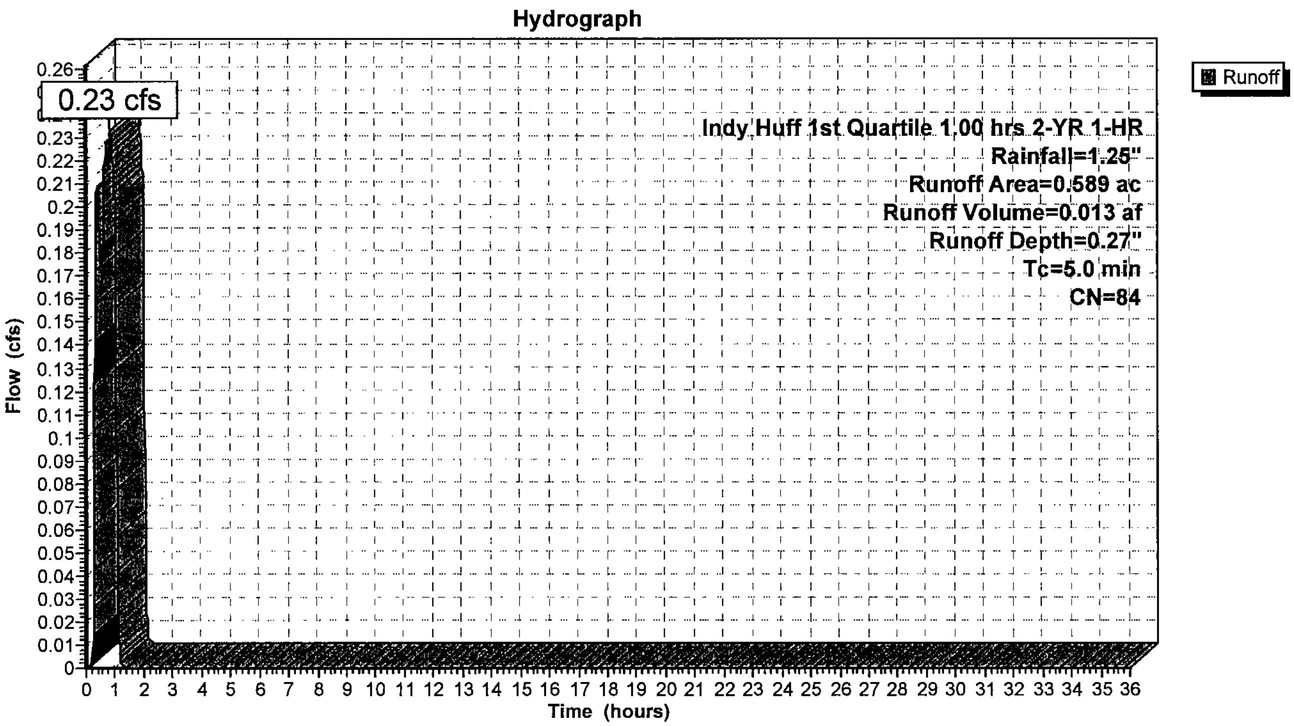
Runoff = 0.23 cfs @ 0.86 hrs, Volume= 0.013 af, Depth= 0.27"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 2-YR 1-HR Rainfall=1.25"

	Area (ac)	CN	Description
*	0.550	84	50-75% Grass Cover, Fair, HSG D
*	0.039	91	Gravel
	0.589	84	Weighted Average
	0.589		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: AREA TO BASIN 2



Summary for Pond 5P: BASIN 1

[87] Warning: Oscillations may require Finer Routing or smaller dt

Inflow Area = 3.920 ac, 18.80% Impervious, Inflow Depth = 0.54" for 2-YR 1-HR event
Inflow = 3.57 cfs @ 0.35 hrs, Volume= 0.177 af
Outflow = 2.44 cfs @ 0.48 hrs, Volume= 0.178 af, Atten= 32%, Lag= 7.8 min
Primary = 2.44 cfs @ 0.48 hrs, Volume= 0.178 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.18' @ 0.48 hrs Surf.Area= 5,803 sf Storage= 806 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 4.5 min (41.5 - 37.1)

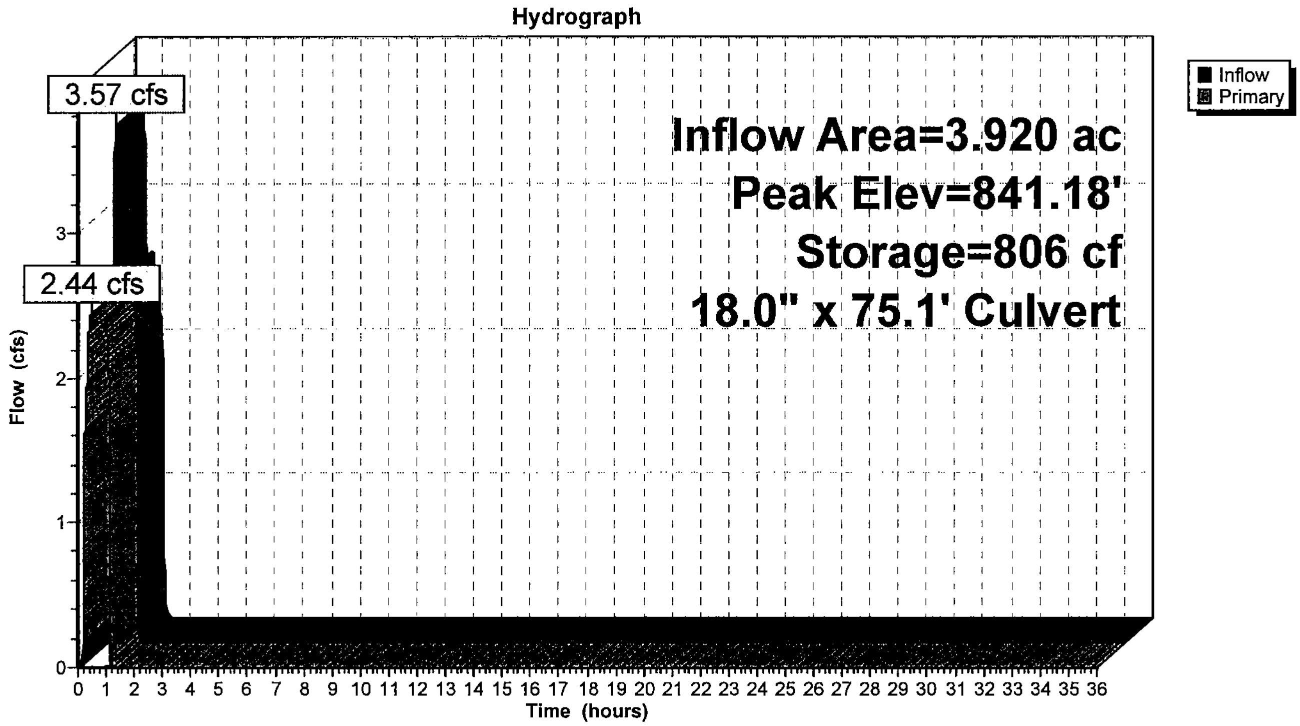
Volume	Invert	Avail.Storage	Storage Description
#1	841.00'	93,677 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
841.00	2,922	0	0
842.00	18,515	10,719	10,719
843.00	42,406	30,461	41,179
844.00	62,589	52,498	93,677

Device	Routing	Invert	Outlet Devices
#1	Primary	840.30'	**18.0" x 75.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.00' S= 0.0040 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=2.44 cfs @ 0.48 hrs HW=841.18' TW=839.17' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 2.44 cfs @ 3.24 fps)

Pond 5P: BASIN 1



Summary for Pond 6P: POCKET WETLAND

Inflow Area =	1.738 ac,	3.16% Impervious,	Inflow Depth = 0.41"	for 2-YR 1-HR event	
Inflow =	1.09 cfs @	0.37 hrs,	Volume=	0.059 af	
Outflow =	0.20 cfs @	1.09 hrs,	Volume=	0.055 af,	Atten= 81%, Lag= 43.3 min
Primary =	0.20 cfs @	1.09 hrs,	Volume=	0.055 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 840.80' @ 1.09 hrs Surf.Area= 7,721 sf Storage= 2,297 cf

Plug-Flow detention time= 301.8 min calculated for 0.055 af (93% of inflow)
Center-of-Mass det. time= 300.4 min (339.6 - 39.1)

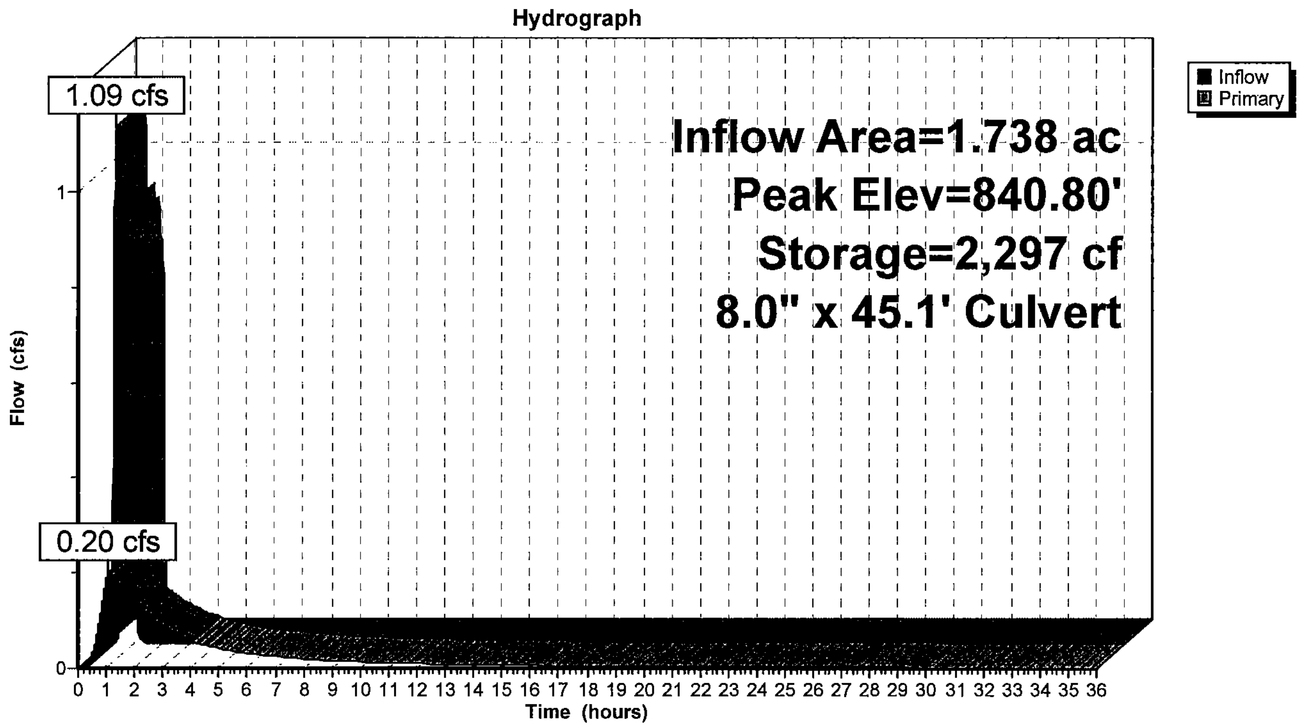
Volume	Invert	Avail.Storage	Storage Description
#1	840.50'	36,708 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
840.50	7,342	0	0
841.00	7,963	3,826	3,826
842.00	13,900	10,932	14,758
843.00	30,000	21,950	36,708

Device	Routing	Invert	Outlet Devices
#1	Primary	840.50'	**8.0" x 45.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.30' S= 0.0044 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=0.20 cfs @ 1.09 hrs HW=840.80' TW=839.57' (Dynamic Tailwater)
1=Culvert (Barrel Controls 0.20 cfs @ 1.91 fps)

Pond 6P: POCKET WETLAND



Summary for Pond 7P: BASIN 2

Inflow Area = 6.247 ac, 12.68% Impervious, Inflow Depth > 0.47" for 2-YR 1-HR event
Inflow = 2.77 cfs @ 0.89 hrs, Volume= 0.246 af
Outflow = 2.22 cfs @ 1.11 hrs, Volume= 0.246 af, Atten= 20%, Lag= 13.0 min
Primary = 2.22 cfs @ 1.11 hrs, Volume= 0.246 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 839.57' @ 1.11 hrs Surf.Area= 6,095 sf Storage= 4,144 cf

Plug-Flow detention time= 37.3 min calculated for 0.246 af (100% of inflow)
Center-of-Mass det. time= 36.5 min (144.5 - 108.0)

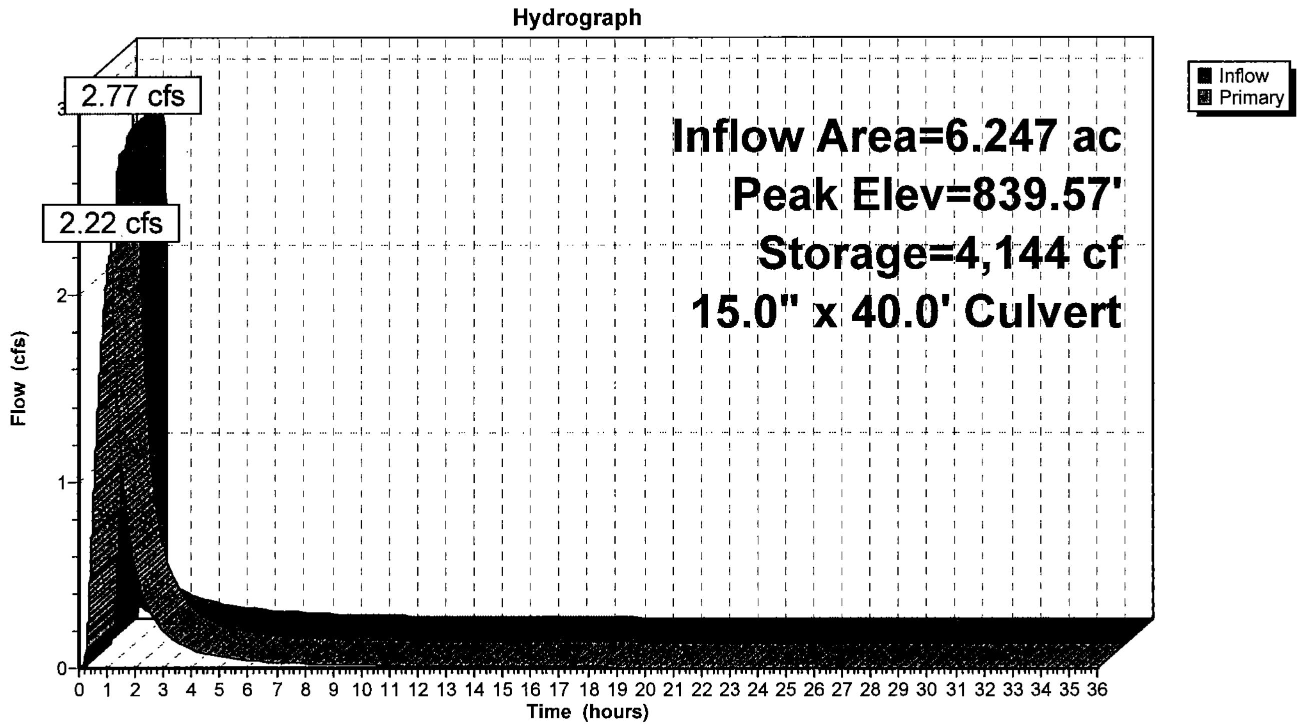
Volume	Invert	Avail.Storage	Storage Description
#1	838.70'	26,266 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
838.70	0	0	0
839.00	5,568	835	835
840.00	6,496	6,032	6,867
841.00	7,484	6,990	13,857
842.00	8,531	8,008	21,865
842.50	9,076	4,402	26,266

Device	Routing	Invert	Outlet Devices
#1	Primary	838.70'	**15.0" x 40.0' long Culvert** RCP, sq.cut end projecting, Ke= 0.500 Outlet Invert= 838.50' S= 0.0050 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=2.22 cfs @ 1.11 hrs HW=839.57' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 2.22 cfs @ 3.44 fps)

Pond 7P: BASIN 2

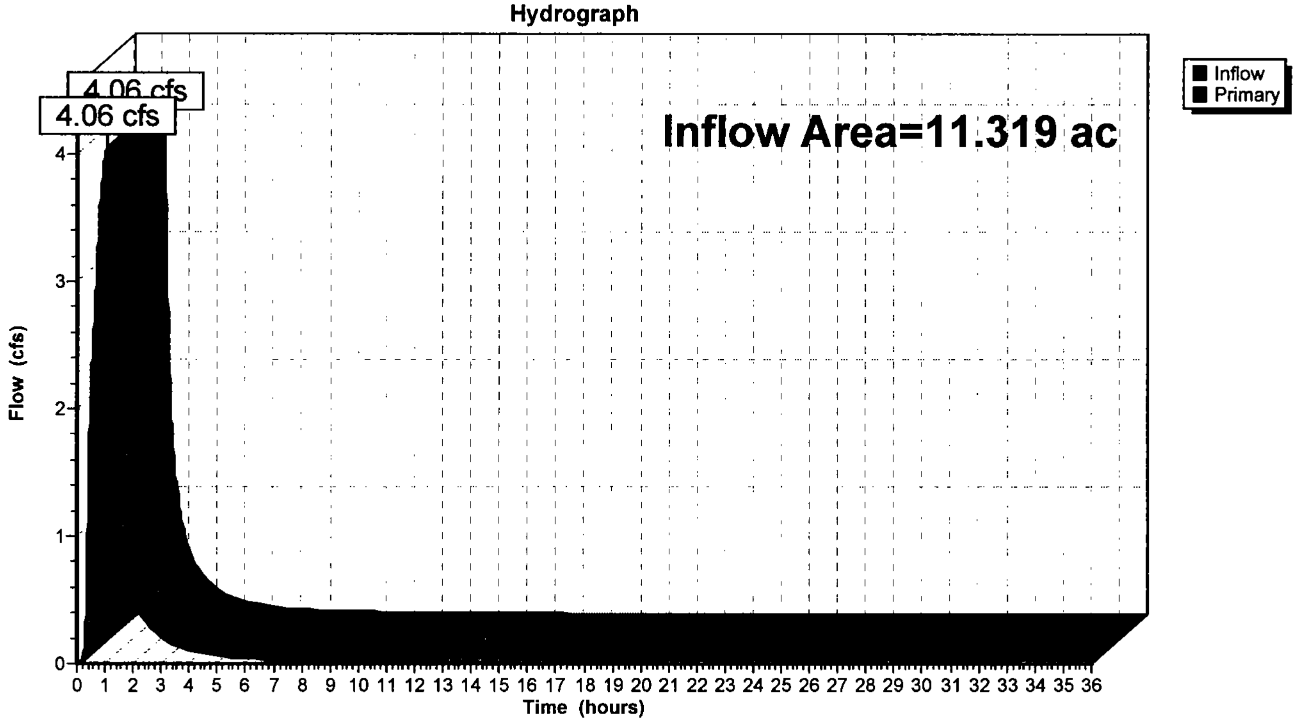


Summary for Link 8L: TOTAL POSTDEVELOPED

Inflow Area =	11.319 ac,	7.70% Impervious,	Inflow Depth > 0.38"	for 2-YR 1-HR event	
Inflow =	4.06 cfs @	1.03 hrs, Volume=	0.361 af		
Primary =	4.06 cfs @	1.03 hrs, Volume=	0.361 af,	Atten= 0%,	Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 8L: TOTAL POSTDEVELOPED



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 2S: AREA TO BASIN 1 Runoff Area=3.920 ac 18.80% Impervious Runoff Depth=1.13"
Tc=5.0 min CN=91 Runoff=8.13 cfs 0.369 af

Subcatchment 3S: AREA TO BASIN 2 Runoff Area=1.738 ac 3.16% Impervious Runoff Depth=0.93"
Tc=5.0 min CN=88 Runoff=2.81 cfs 0.135 af

Subcatchment 4S: UNMANAGED AREA Runoff Area=5.072 ac 1.58% Impervious Runoff Depth=0.72"
Tc=14.3 min CN=84 Runoff=4.55 cfs 0.303 af

Subcatchment 9S: AREA TO BASIN 2 Runoff Area=0.589 ac 0.00% Impervious Runoff Depth=0.72"
Tc=5.0 min CN=84 Runoff=0.67 cfs 0.035 af

Pond 5P: BASIN 1 Peak Elev=841.55' Storage=3,909 cf Inflow=8.13 cfs 0.369 af
18.0" x 75.1' Culvert Outflow=4.27 cfs 0.369 af

Pond 6P: POCKET WETLAND Peak Elev=841.12' Storage=4,785 cf Inflow=2.81 cfs 0.135 af
8.0" x 45.1' Culvert Outflow=0.65 cfs 0.131 af

Pond 7P: BASIN 2 Peak Elev=840.06' Storage=7,284 cf Inflow=5.32 cfs 0.535 af
15.0" x 40.0' Culvert Outflow=4.37 cfs 0.534 af

Link 8L: TOTAL POSTDEVELOPED Inflow=8.40 cfs 0.837 af
Primary=8.40 cfs 0.837 af

Total Runoff Area = 11.319 ac Runoff Volume = 0.841 af Average Runoff Depth = 0.89"
92.30% Pervious = 10.447 ac 7.70% Impervious = 0.872 ac

Summary for Subcatchment 2S: AREA TO BASIN 1

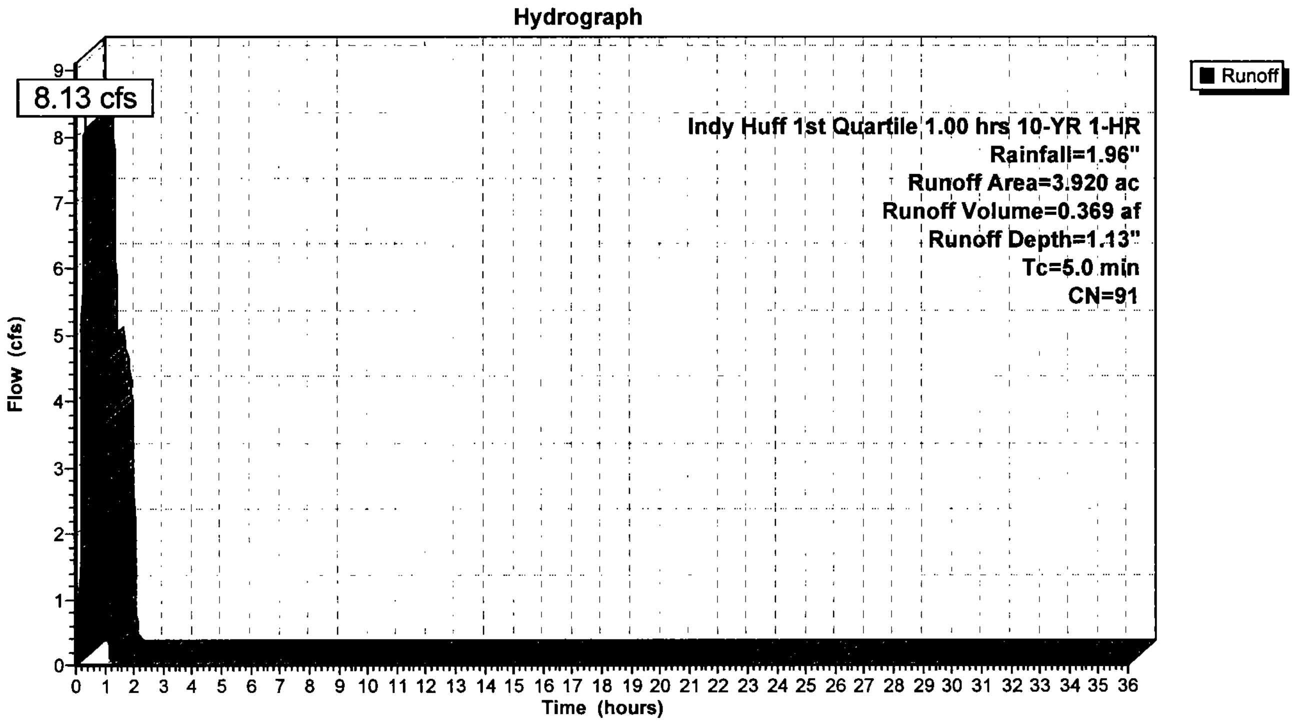
Runoff = 8.13 cfs @ 0.32 hrs, Volume= 0.369 af, Depth= 1.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 10-YR 1-HR Rainfall=1.96"

	Area (ac)	CN	Description
	0.737	98	Paved parking & roofs
	2.629	91	Gravel roads, HSG D
*	0.554	84	50-75% Grass Cover, Fair, HSG D
	3.920	91	Weighted Average
	3.183		Pervious Area
	0.737		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: AREA TO BASIN 1



Summary for Subcatchment 3S: AREA TO BASIN 2

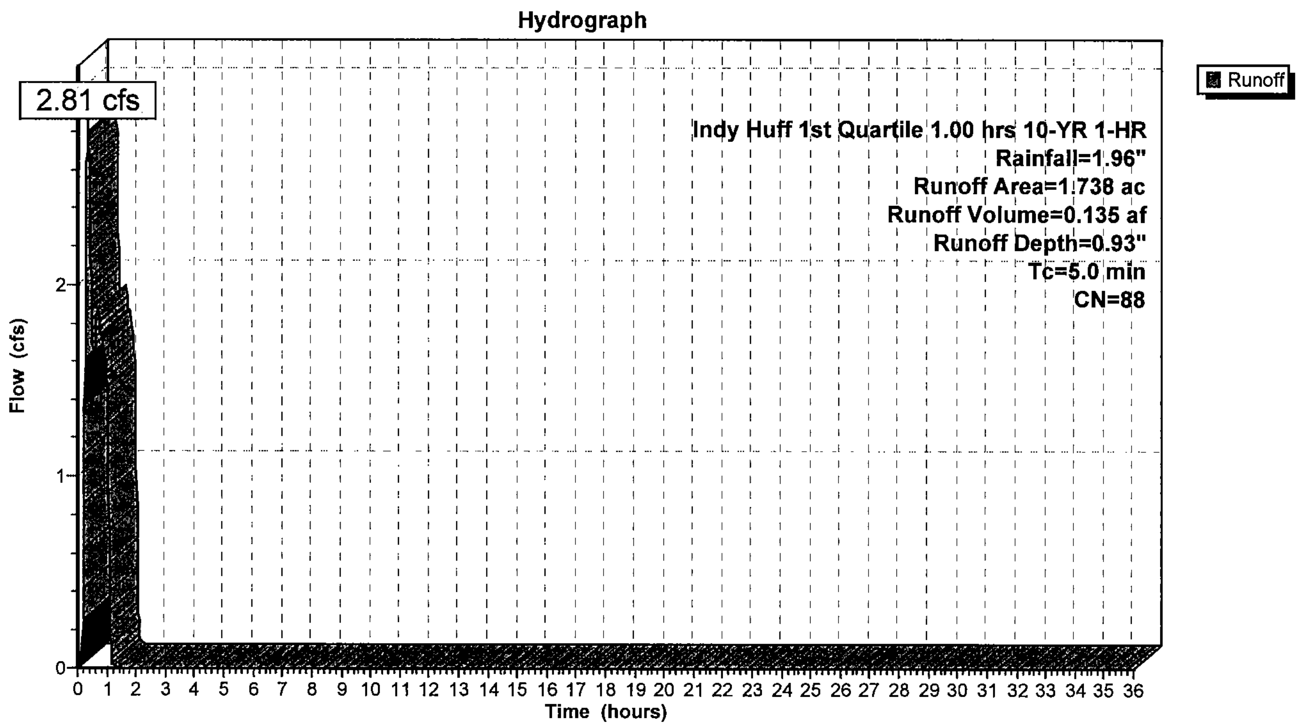
Runoff = 2.81 cfs @ 0.34 hrs, Volume= 0.135 af, Depth= 0.93"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 10-YR 1-HR Rainfall=1.96"

Area (ac)	CN	Description
0.055	98	Paved parking & roofs
0.888	84	50-75% Grass cover, Fair, HSG D
0.795	91	Gravel roads, HSG D
1.738	88	Weighted Average
1.683		Pervious Area
0.055		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: AREA TO BASIN 2



Summary for Subcatchment 4S: UNMANAGED AREA

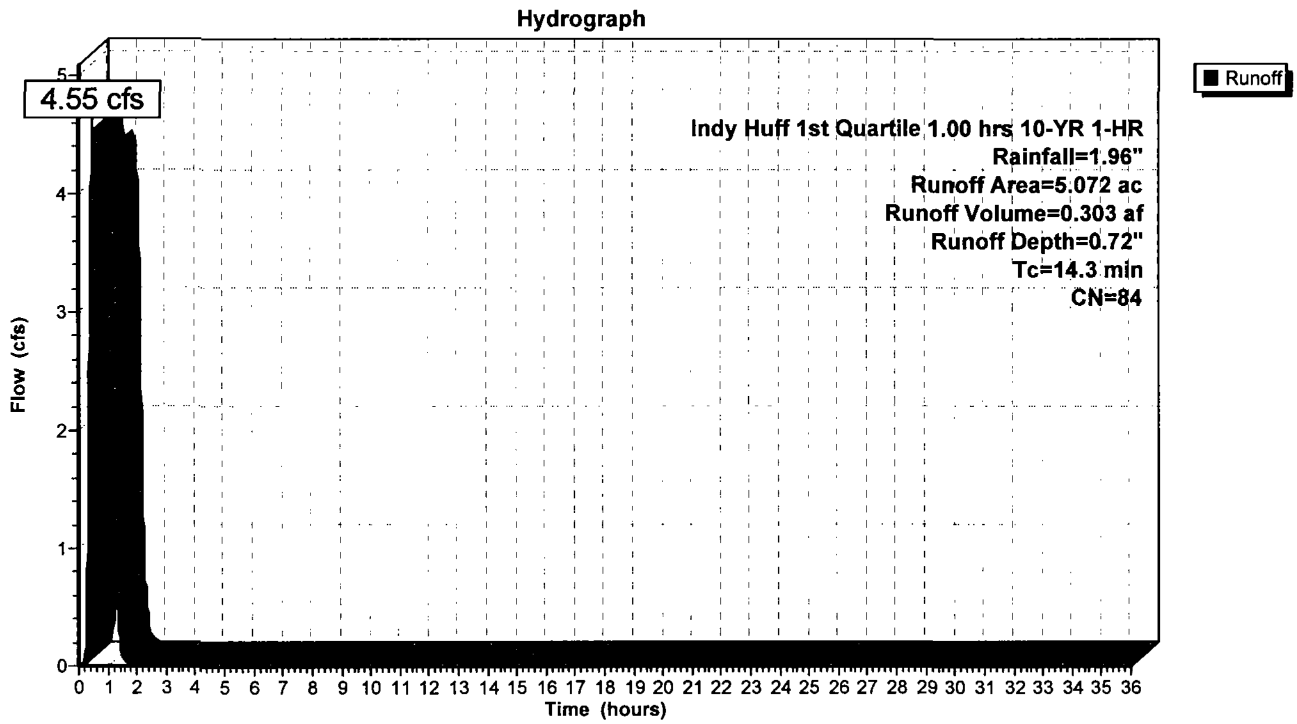
Runoff = 4.55 cfs @ 0.51 hrs, Volume= 0.303 af, Depth= 0.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 10-YR 1-HR Rainfall=1.96"

	Area (ac)	CN	Description
	3.435	84	50-75% Grass cover, Fair, HSG D
	0.671	91	Gravel roads, HSG D
	0.886	77	Woods, Good, HSG D
*	0.080	98	Paved Parking & Roads
	5.072	84	Weighted Average
	4.992		Pervious Area
	0.080		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry,**

Subcatchment 4S: UNMANAGED AREA



Summary for Subcatchment 9S: AREA TO BASIN 2

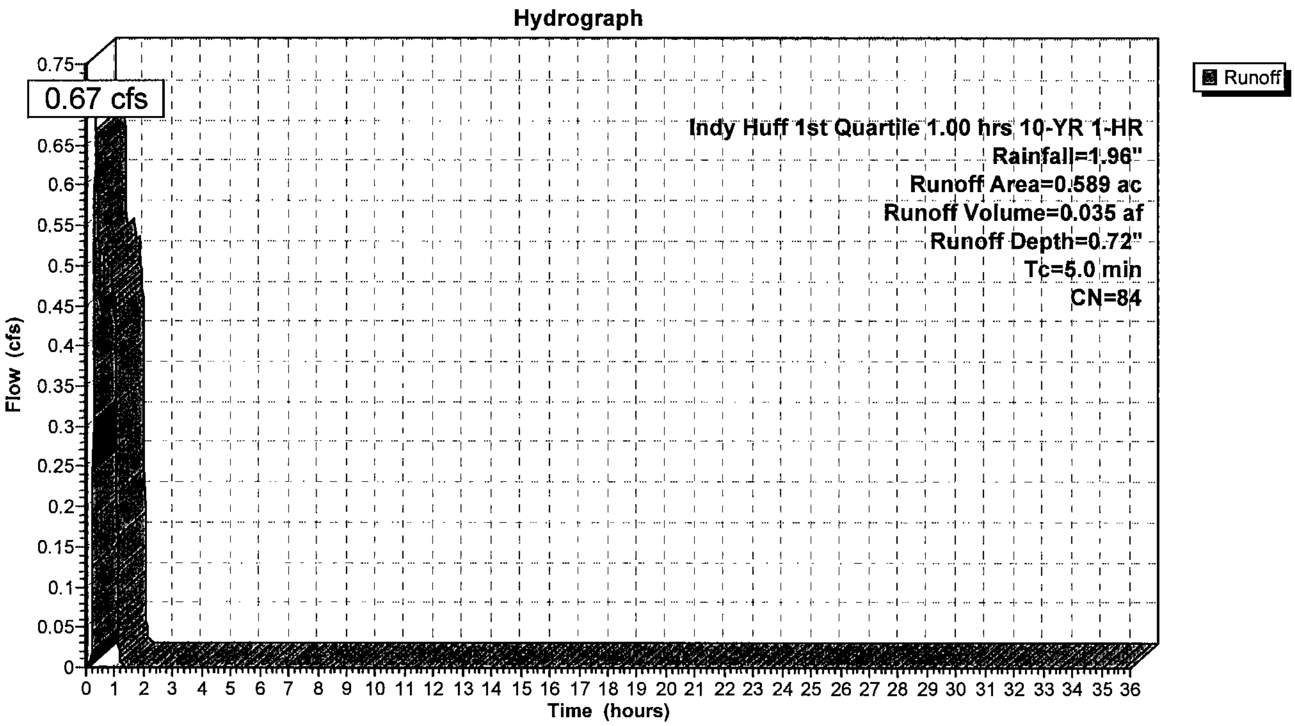
Runoff = 0.67 cfs @ 0.36 hrs, Volume= 0.035 af, Depth= 0.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 10-YR 1-HR Rainfall=1.96"

	Area (ac)	CN	Description
*	0.550	84	50-75% Grass Cover, Fair, HSG D
*	0.039	91	Gravel
	0.589	84	Weighted Average
	0.589		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: AREA TO BASIN 2



Summary for Pond 5P: BASIN 1

Inflow Area = 3.920 ac, 18.80% Impervious, Inflow Depth = 1.13" for 10-YR 1-HR event
Inflow = 8.13 cfs @ 0.32 hrs, Volume= 0.369 af
Outflow = 4.27 cfs @ 0.89 hrs, Volume= 0.369 af, Atten= 48%, Lag= 34.2 min
Primary = 4.27 cfs @ 0.89 hrs, Volume= 0.369 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.55' @ 0.89 hrs Surf.Area= 11,421 sf Storage= 3,909 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 12.5 min (47.3 - 34.8)

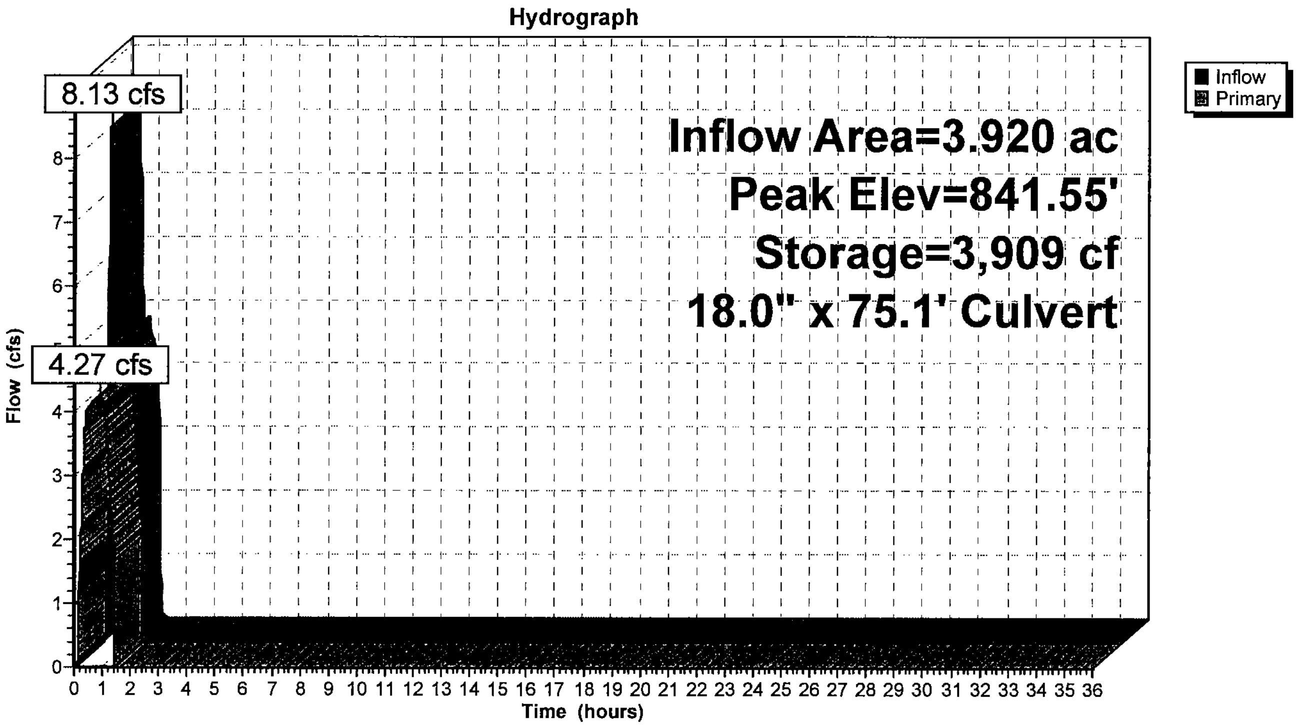
Volume	Invert	Avail.Storage	Storage Description
#1	841.00'	93,677 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
841.00	2,922	0	0
842.00	18,515	10,719	10,719
843.00	42,406	30,461	41,179
844.00	62,589	52,498	93,677

Device	Routing	Invert	Outlet Devices
#1	Primary	840.30'	**18.0" x 75.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.00' S= 0.0040 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=4.27 cfs @ 0.89 hrs HW=841.55' TW=839.94' (Dynamic Tailwater)
1=Culvert (Barrel Controls 4.27 cfs @ 3.69 fps)

Pond 5P: BASIN 1



Summary for Pond 6P: POCKET WETLAND

Inflow Area = 1.738 ac, 3.16% Impervious, Inflow Depth = 0.93" for 10-YR 1-HR event
Inflow = 2.81 cfs @ 0.34 hrs, Volume= 0.135 af
Outflow = 0.65 cfs @ 1.07 hrs, Volume= 0.131 af, Atten= 77%, Lag= 44.1 min
Primary = 0.65 cfs @ 1.07 hrs, Volume= 0.131 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.12' @ 1.07 hrs Surf.Area= 8,649 sf Storage= 4,785 cf

Plug-Flow detention time= 199.1 min calculated for 0.131 af (97% of inflow)
Center-of-Mass det. time= 198.2 min (234.5 - 36.4)

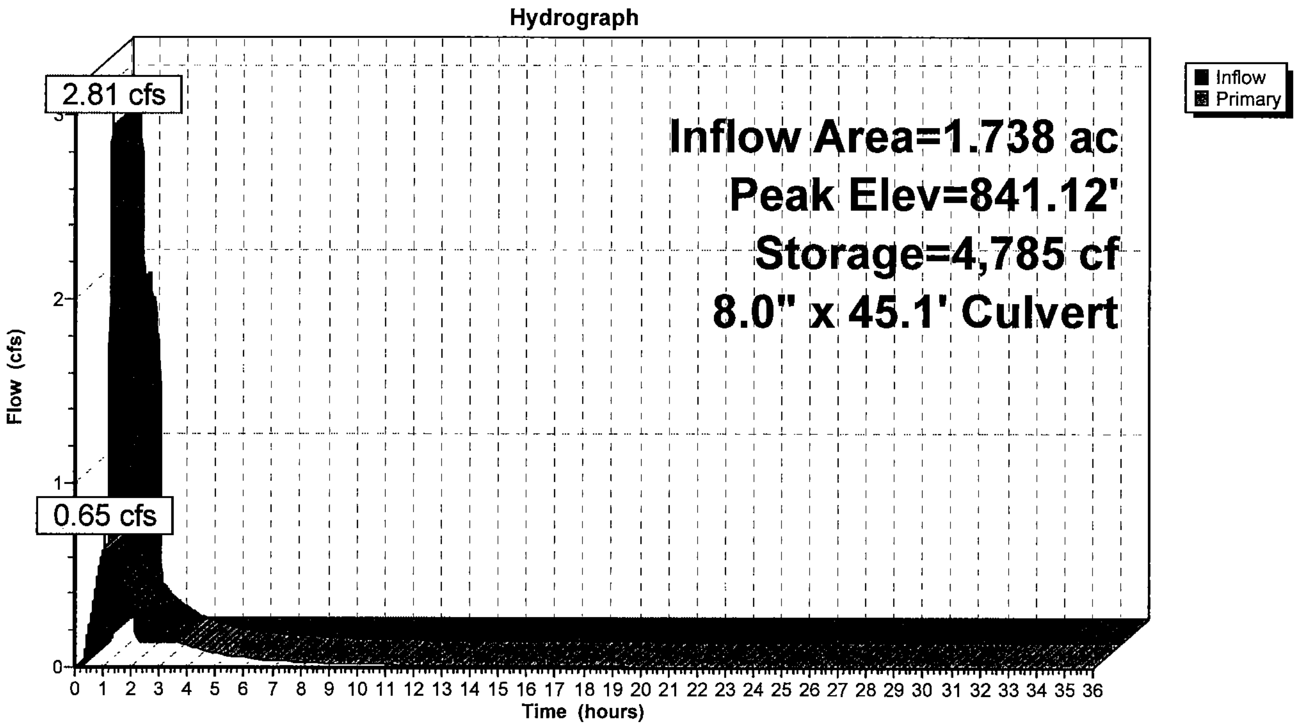
Volume	Invert	Avail.Storage	Storage Description
#1	840.50'	36,708 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
840.50	7,342	0	0
841.00	7,963	3,826	3,826
842.00	13,900	10,932	14,758
843.00	30,000	21,950	36,708

Device	Routing	Invert	Outlet Devices
#1	Primary	840.50'	**8.0" x 45.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.30' S= 0.0044 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=0.65 cfs @ 1.07 hrs HW=841.12' TW=840.05' (Dynamic Tailwater)
1=Culvert (Barrel Controls 0.65 cfs @ 2.53 fps)

Pond 6P: POCKET WETLAND



Summary for Pond 7P: BASIN 2

Inflow Area = 6.247 ac, 12.68% Impervious, Inflow Depth > 1.03" for 10-YR 1-HR event
Inflow = 5.32 cfs @ 0.90 hrs, Volume= 0.535 af
Outflow = 4.37 cfs @ 1.14 hrs, Volume= 0.534 af, Atten= 18%, Lag= 14.1 min
Primary = 4.37 cfs @ 1.14 hrs, Volume= 0.534 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 840.06' @ 1.14 hrs Surf.Area= 6,559 sf Storage= 7,284 cf

Plug-Flow detention time= 32.6 min calculated for 0.534 af (100% of inflow)
Center-of-Mass det. time= 32.1 min (124.6 - 92.5)

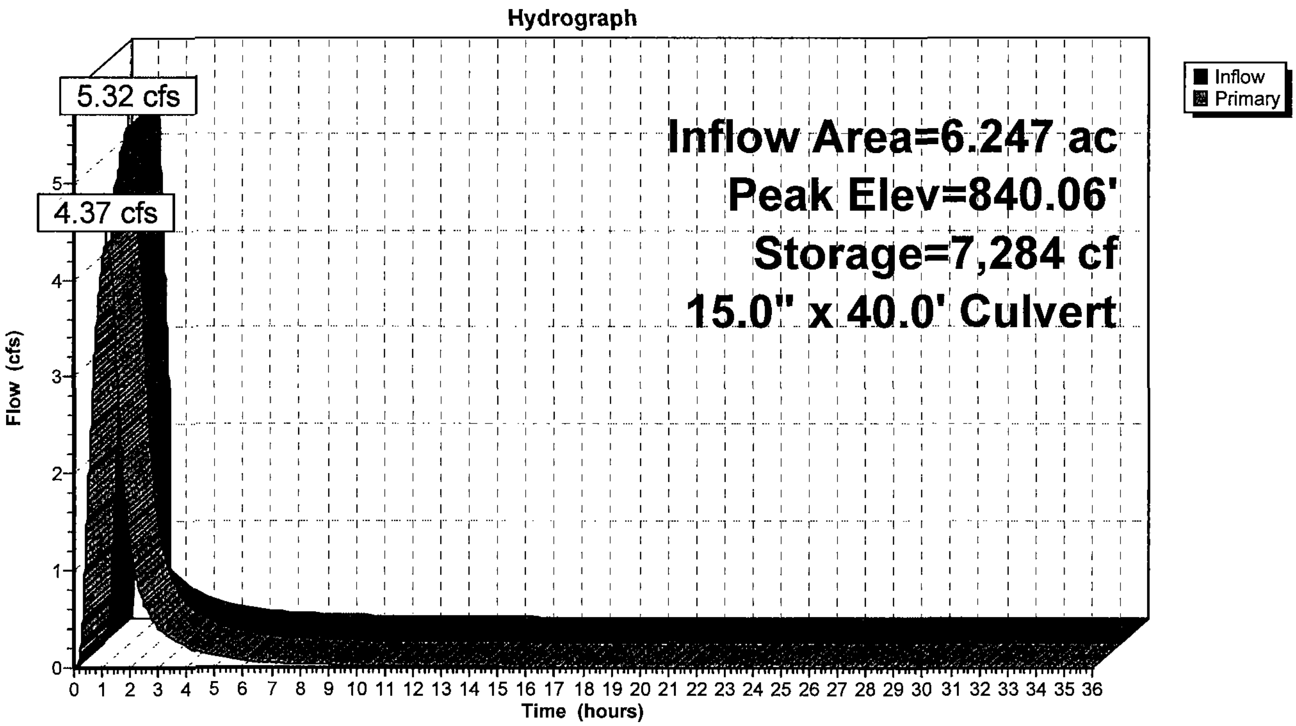
Volume	Invert	Avail.Storage	Storage Description
#1	838.70'	26,266 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
838.70	0	0	0
839.00	5,568	835	835
840.00	6,496	6,032	6,867
841.00	7,484	6,990	13,857
842.00	8,531	8,008	21,865
842.50	9,076	4,402	26,266

Device	Routing	Invert	Outlet Devices
#1	Primary	838.70'	**15.0" x 40.0' long Culvert** RCP, sq.cut end projecting, Ke= 0.500 Outlet Invert= 838.50' S= 0.0050 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=4.37 cfs @ 1.14 hrs HW=840.06' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 4.37 cfs @ 4.06 fps)

Pond 7P: BASIN 2

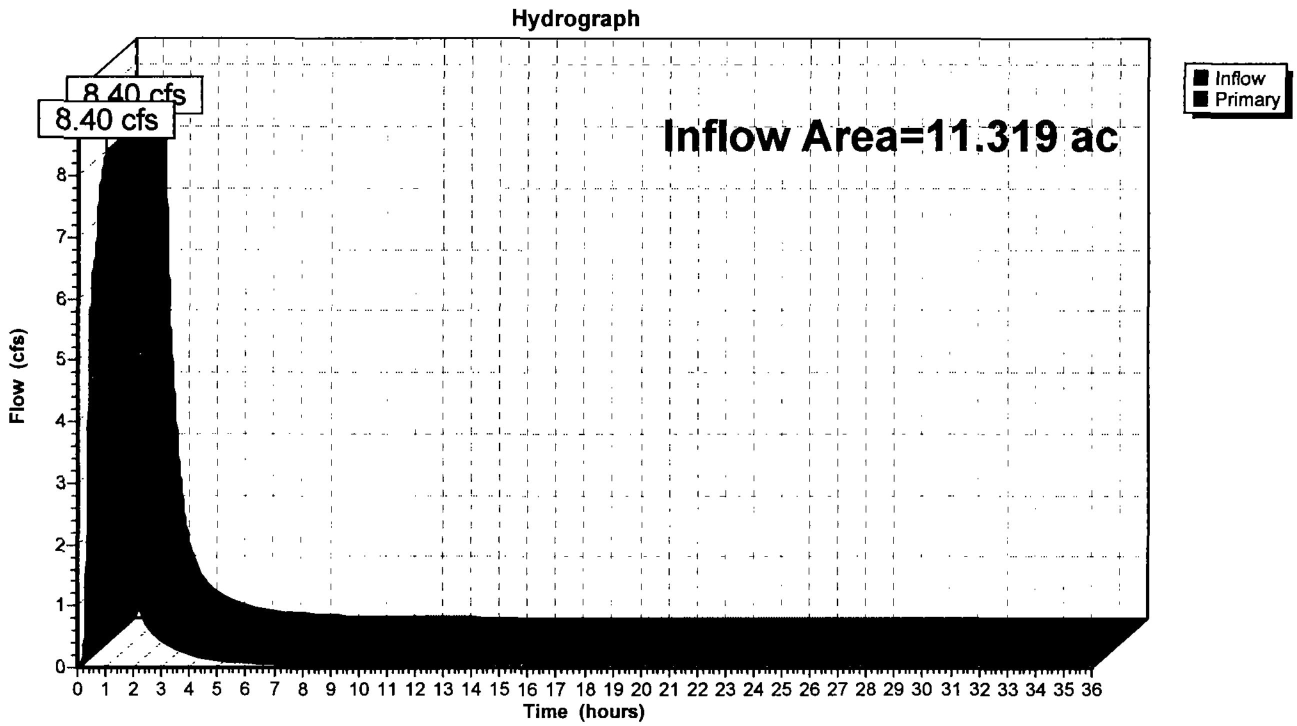


Summary for Link 8L: TOTAL POSTDEVELOPED

Inflow Area =	11.319 ac,	7.70% Impervious, Inflow Depth > 0.89"	for 10-YR 1-HR event	
Inflow =	8.40 cfs @	1.00 hrs, Volume=	0.837 af	
Primary =	8.40 cfs @	1.00 hrs, Volume=	0.837 af, Atten= 0%,	Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 8L: TOTAL POSTDEVELOPED



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 2S: AREA TO BASIN 1 Runoff Area=3.920 ac 18.80% Impervious Runoff Depth=1.44"
Tc=5.0 min CN=91 Runoff=10.64 cfs 0.470 af

Subcatchment 3S: AREA TO BASIN 2 Runoff Area=1.738 ac 3.16% Impervious Runoff Depth=1.22"
Tc=5.0 min CN=88 Runoff=3.79 cfs 0.177 af

Subcatchment 4S: UNMANAGED AREA Runoff Area=5.072 ac 1.58% Impervious Runoff Depth=0.97"
Tc=14.3 min CN=84 Runoff=6.46 cfs 0.410 af

Subcatchment 9S: AREA TO BASIN 2 Runoff Area=0.589 ac 0.00% Impervious Runoff Depth=0.97"
Tc=5.0 min CN=84 Runoff=0.95 cfs 0.048 af

Pond 5P: BASIN 1 Peak Elev=841.71' Storage=5,945 cf Inflow=10.64 cfs 0.470 af
18.0" x 75.1' Culvert Outflow=5.11 cfs 0.470 af

Pond 6P: POCKET WETLAND Peak Elev=841.26' Storage=6,104 cf Inflow=3.79 cfs 0.177 af
8.0" x 45.1' Culvert Outflow=0.85 cfs 0.172 af

Pond 7P: BASIN 2 Peak Elev=840.32' Storage=8,975 cf Inflow=6.51 cfs 0.690 af
15.0" x 40.0' Culvert Outflow=5.13 cfs 0.690 af

Link 8L: TOTAL POSTDEVELOPED Inflow=10.43 cfs 1.100 af
Primary=10.43 cfs 1.100 af

Total Runoff Area = 11.319 ac Runoff Volume = 1.105 af Average Runoff Depth = 1.17"
92.30% Pervious = 10.447 ac 7.70% Impervious = 0.872 ac

Summary for Subcatchment 2S: AREA TO BASIN 1

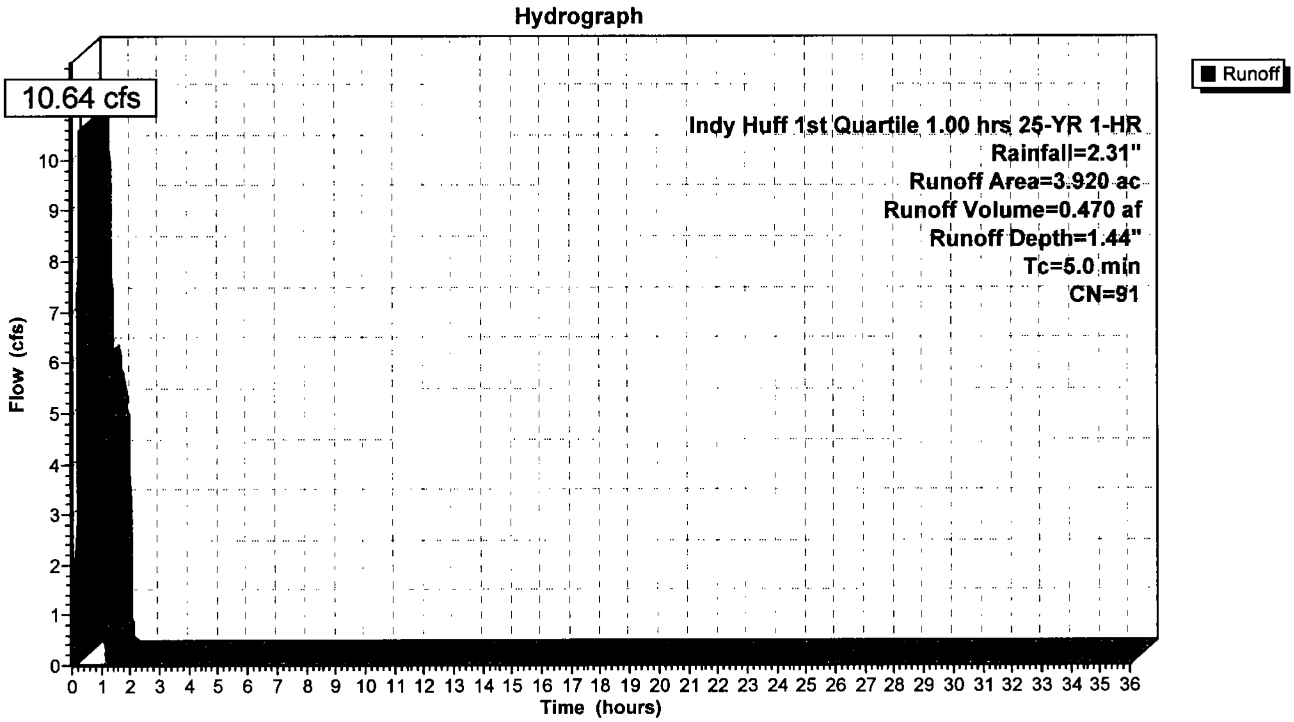
Runoff = 10.64 cfs @ 0.31 hrs, Volume= 0.470 af, Depth= 1.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 25-YR 1-HR Rainfall=2.31"

	Area (ac)	CN	Description
	0.737	98	Paved parking & roofs
	2.629	91	Gravel roads, HSG D
*	0.554	84	50-75% Grass Cover, Fair, HSG D
	3.920	91	Weighted Average
	3.183		Pervious Area
	0.737		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: AREA TO BASIN 1



Summary for Subcatchment 3S: AREA TO BASIN 2

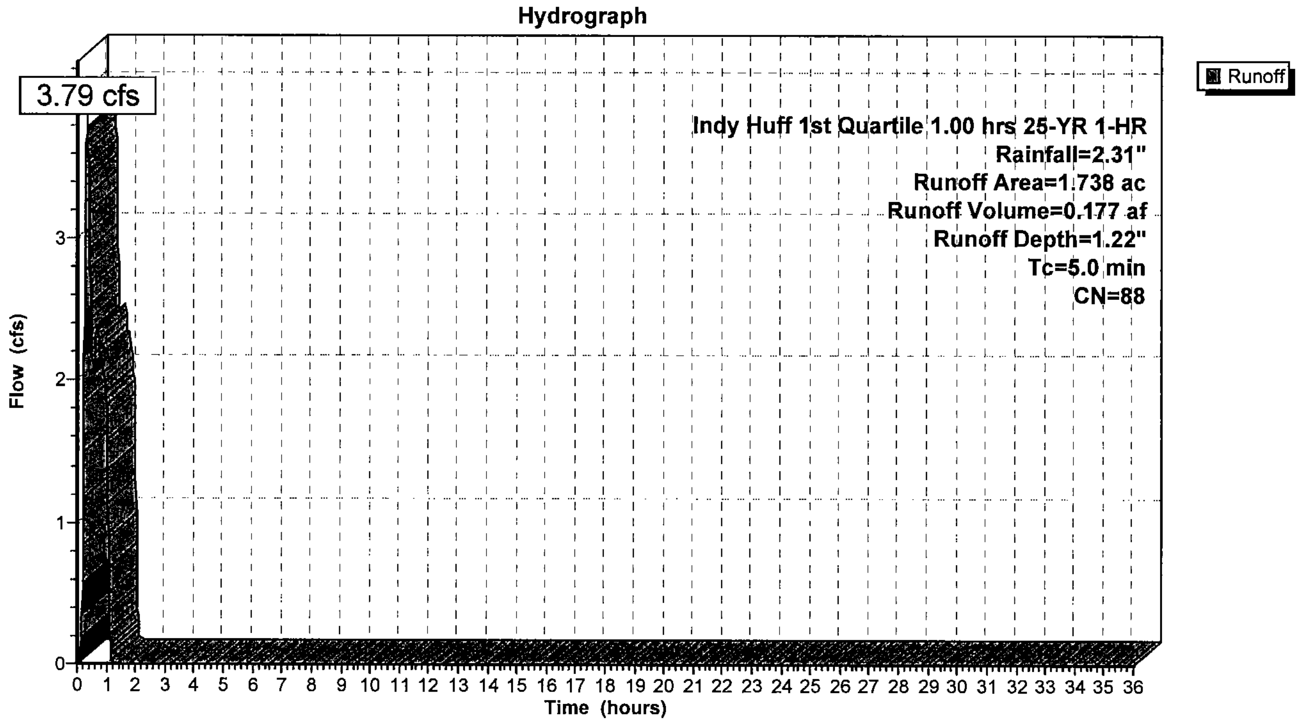
Runoff = 3.79 cfs @ 0.33 hrs, Volume= 0.177 af, Depth= 1.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 25-YR 1-HR Rainfall=2.31"

Area (ac)	CN	Description
0.055	98	Paved parking & roofs
0.888	84	50-75% Grass cover, Fair, HSG D
0.795	91	Gravel roads, HSG D
1.738	88	Weighted Average
1.683		Pervious Area
0.055		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: AREA TO BASIN 2



Summary for Subcatchment 4S: UNMANAGED AREA

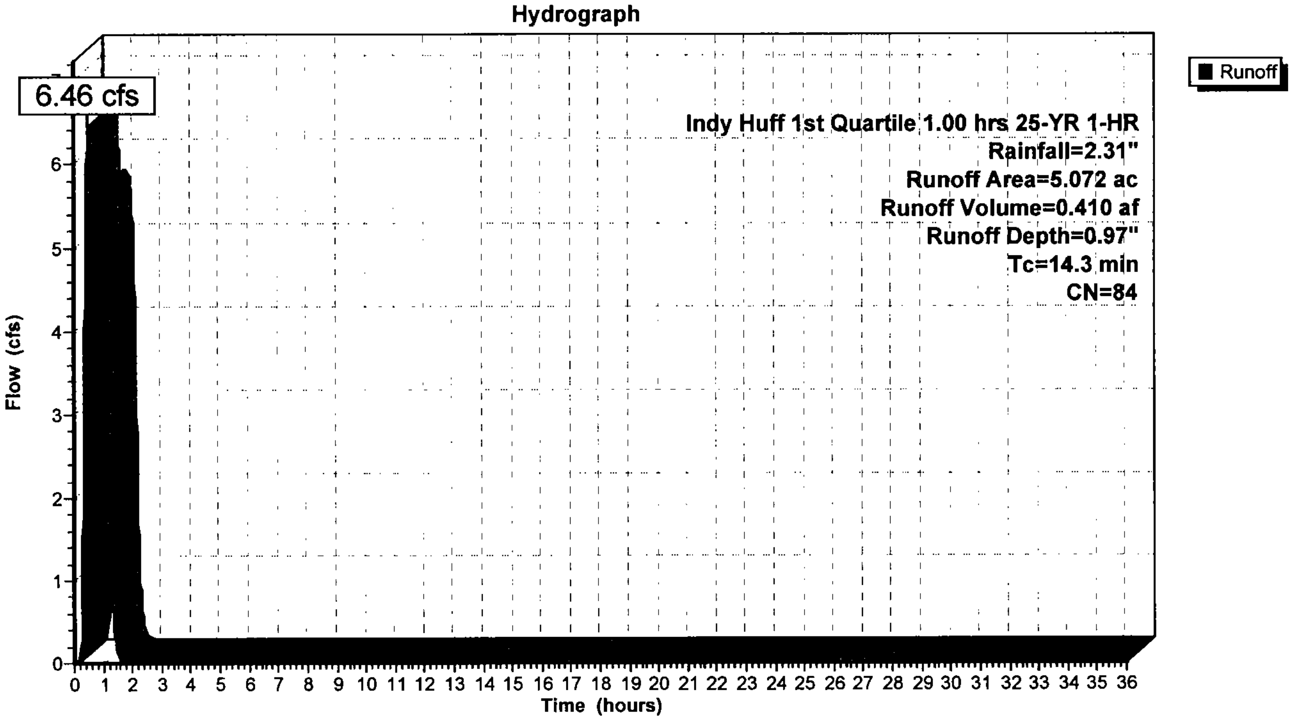
Runoff = 6.46 cfs @ 0.49 hrs, Volume= 0.410 af, Depth= 0.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 25-YR 1-HR Rainfall=2.31"

	Area (ac)	CN	Description
	3.435	84	50-75% Grass cover, Fair, HSG D
	0.671	91	Gravel roads, HSG D
	0.886	77	Woods, Good, HSG D
*	0.080	98	Paved Parking & Roads
	5.072	84	Weighted Average
	4.992		Pervious Area
	0.080		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry,**

Subcatchment 4S: UNMANAGED AREA



Summary for Subcatchment 9S: AREA TO BASIN 2

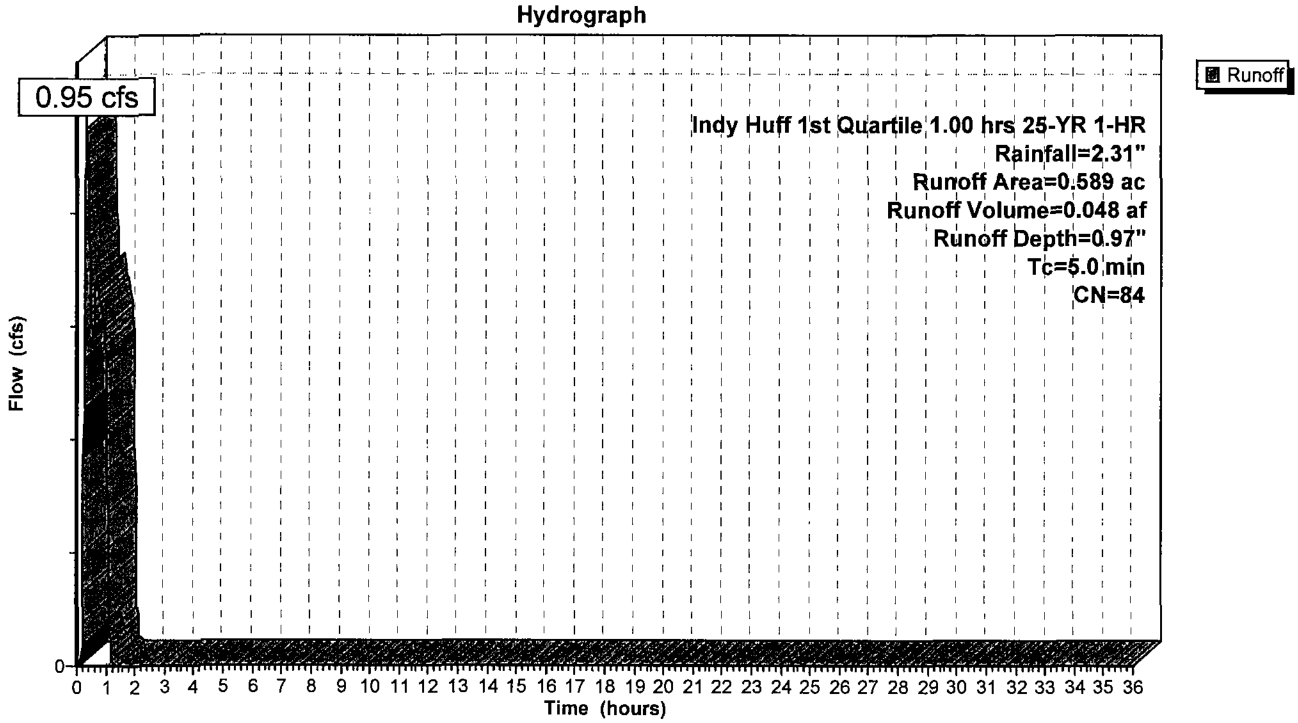
Runoff = 0.95 cfs @ 0.35 hrs, Volume= 0.048 af, Depth= 0.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 25-YR 1-HR Rainfall=2.31"

	Area (ac)	CN	Description
*	0.550	84	50-75% Grass Cover, Fair, HSG D
*	0.039	91	Gravel
	0.589	84	Weighted Average
	0.589		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: AREA TO BASIN 2



Summary for Pond 5P: BASIN 1

Inflow Area =	3.920 ac,	18.80% Impervious,	Inflow Depth = 1.44"	for 25-YR 1-HR event
Inflow =	10.64 cfs @	0.31 hrs, Volume=	0.470 af	
Outflow =	5.11 cfs @	0.90 hrs, Volume=	0.470 af, Atten= 52%, Lag= 35.5 min	
Primary =	5.11 cfs @	0.90 hrs, Volume=	0.470 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.71' @ 0.90 hrs Surf.Area= 13,927 sf Storage= 5,945 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 15.7 min (49.8 - 34.1)

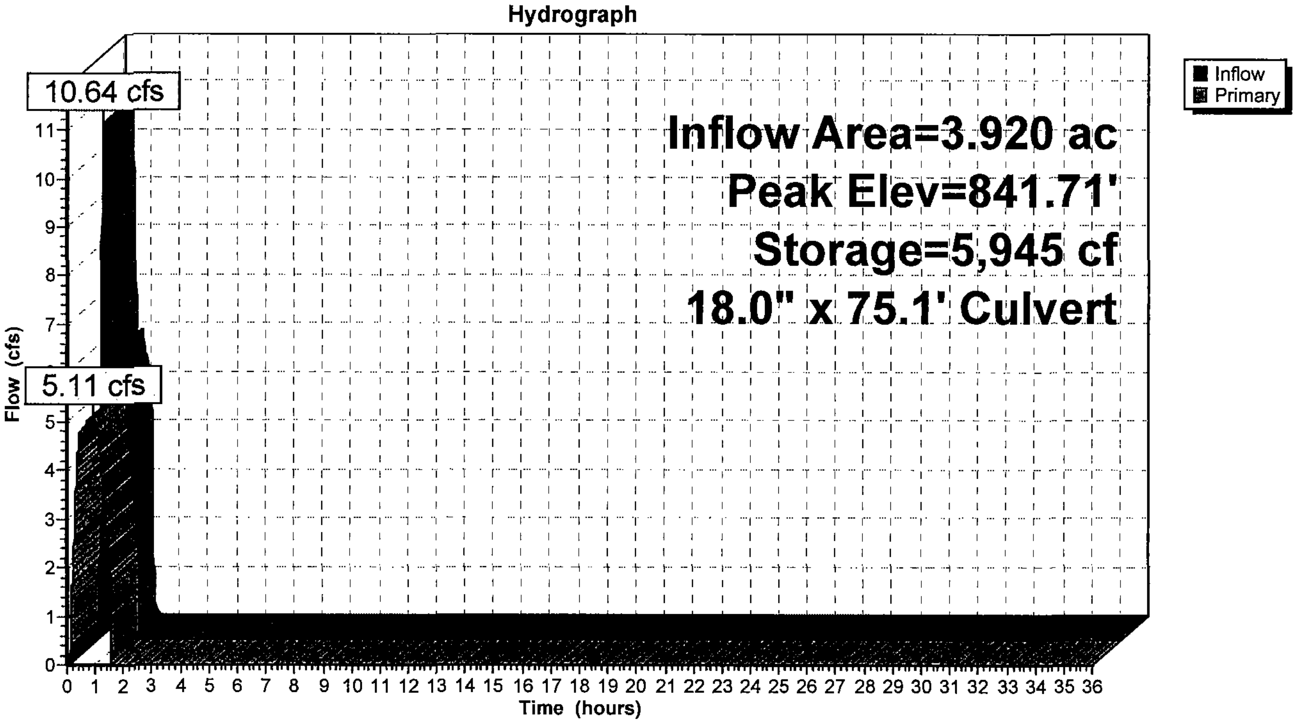
Volume	Invert	Avail.Storage	Storage Description
#1	841.00'	93,677 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
841.00	2,922	0	0
842.00	18,515	10,719	10,719
843.00	42,406	30,461	41,179
844.00	62,589	52,498	93,677

Device	Routing	Invert	Outlet Devices
#1	Primary	840.30'	**18.0" x 75.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.00' S= 0.0040 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=5.11 cfs @ 0.90 hrs HW=841.71' TW=840.16' (Dynamic Tailwater)
1=Culvert (Barrel Controls 5.11 cfs @ 3.85 fps)

Pond 5P: BASIN 1



Summary for Pond 6P: POCKET WETLAND

Inflow Area =	1.738 ac,	3.16% Impervious, Inflow Depth = 1.22"	for 25-YR 1-HR event	
Inflow =	3.79 cfs @	0.33 hrs, Volume=	0.177 af	
Outflow =	0.85 cfs @	1.07 hrs, Volume=	0.172 af,	Atten= 78%, Lag= 44.6 min
Primary =	0.85 cfs @	1.07 hrs, Volume=	0.172 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.26' @ 1.07 hrs Surf.Area= 9,511 sf Storage= 6,104 cf

Plug-Flow detention time= 177.3 min calculated for 0.172 af (97% of inflow)
Center-of-Mass det. time= 176.6 min (212.1 - 35.5)

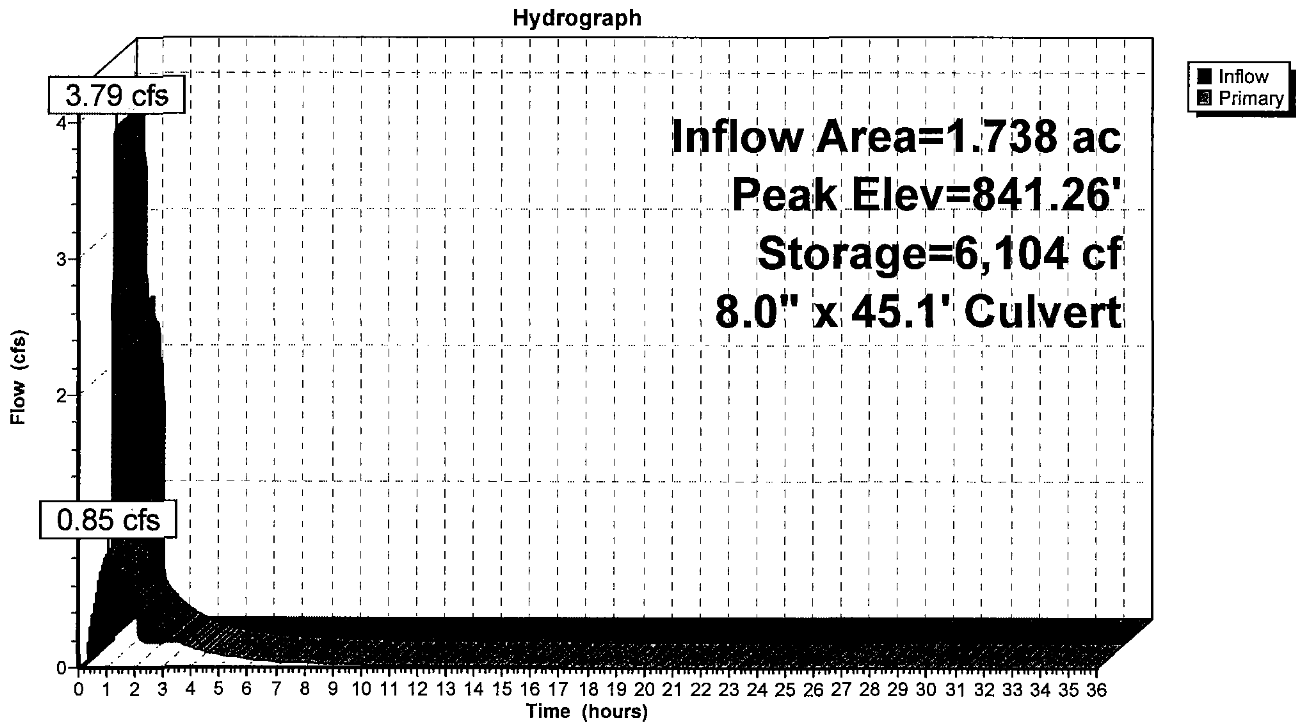
Volume	Invert	Avail.Storage	Storage Description
#1	840.50'	36,708 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
840.50	7,342	0	0
841.00	7,963	3,826	3,826
842.00	13,900	10,932	14,758
843.00	30,000	21,950	36,708

Device	Routing	Invert	Outlet Devices
#1	Primary	840.50'	**8.0" x 45.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.30' S= 0.0044 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=0.85 cfs @ 1.07 hrs HW=841.26' TW=840.29' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.85 cfs @ 2.68 fps)

Pond 6P: POCKET WETLAND



Summary for Pond 7P: BASIN 2

Inflow Area =	6.247 ac,	12.68% Impervious,	Inflow Depth > 1.33"	for 25-YR 1-HR event	
Inflow =	6.51 cfs @	0.90 hrs,	Volume=	0.690 af	
Outflow =	5.13 cfs @	1.18 hrs,	Volume=	0.690 af,	Atten= 21%, Lag= 16.8 min
Primary =	5.13 cfs @	1.18 hrs,	Volume=	0.690 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 840.32' @ 1.18 hrs Surf.Area= 6,809 sf Storage= 8,975 cf

Plug-Flow detention time= 31.8 min calculated for 0.690 af (100% of inflow)
Center-of-Mass det. time= 31.5 min (120.9 - 89.4)

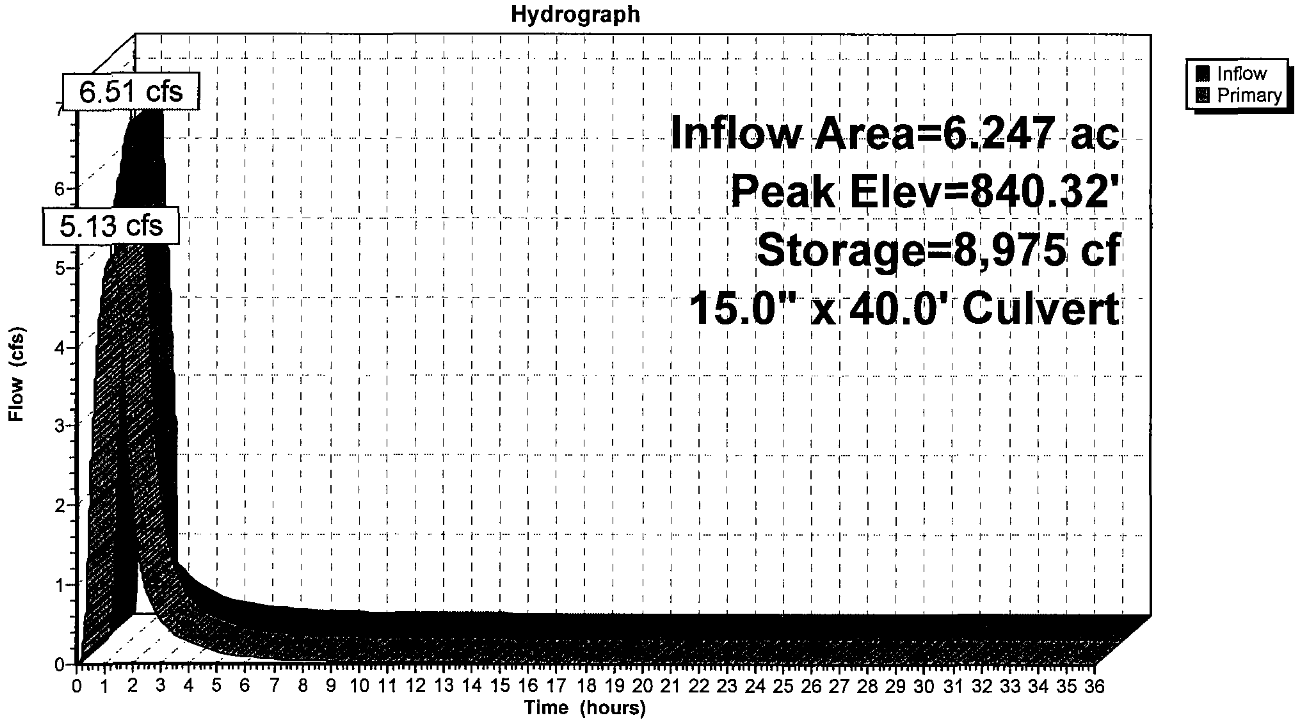
Volume	Invert	Avail.Storage	Storage Description
#1	838.70'	26,266 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
838.70	0	0	0
839.00	5,568	835	835
840.00	6,496	6,032	6,867
841.00	7,484	6,990	13,857
842.00	8,531	8,008	21,865
842.50	9,076	4,402	26,266

Device	Routing	Invert	Outlet Devices
#1	Primary	838.70'	**15.0" x 40.0' long Culvert** RCP, sq.cut end projecting, Ke= 0.500 Outlet Invert= 838.50' S= 0.0050 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=5.13 cfs @ 1.18 hrs HW=840.32' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 5.13 cfs @ 4.22 fps)

Pond 7P: BASIN 2

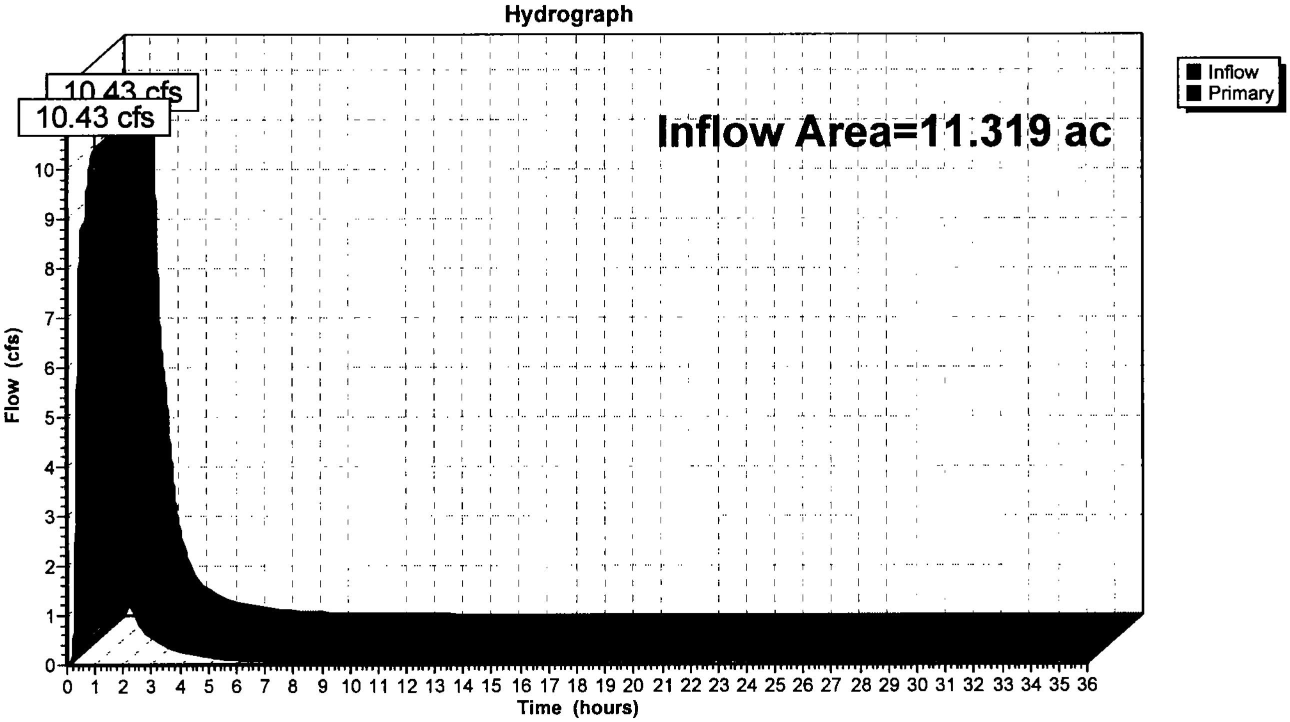


Summary for Link 8L: TOTAL POSTDEVELOPED

Inflow Area =	11.319 ac,	7.70% Impervious,	Inflow Depth > 1.17"	for 25-YR 1-HR event
Inflow =	10.43 cfs @	0.97 hrs, Volume=	1.100 af	
Primary =	10.43 cfs @	0.97 hrs, Volume=	1.100 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 8L: TOTAL POSTDEVELOPED



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 2S: AREA TO BASIN 1 Runoff Area=3.920 ac 18.80% Impervious Runoff Depth=1.96"
Tc=5.0 min CN=91 Runoff=14.93 cfs 0.640 af

Subcatchment 3S: AREA TO BASIN 2 Runoff Area=1.738 ac 3.16% Impervious Runoff Depth=1.71"
Tc=5.0 min CN=88 Runoff=5.53 cfs 0.248 af

Subcatchment 4S: UNMANAGED AREA Runoff Area=5.072 ac 1.58% Impervious Runoff Depth=1.42"
Tc=14.3 min CN=84 Runoff=9.94 cfs 0.599 af

Subcatchment 9S: AREA TO BASIN 2 Runoff Area=0.589 ac 0.00% Impervious Runoff Depth=1.42"
Tc=5.0 min CN=84 Runoff=1.46 cfs 0.070 af

Pond 5P: BASIN 1 Peak Elev=841.95' Storage=9,839 cf Inflow=14.93 cfs 0.640 af
18.0" x 75.1' Culvert Outflow=6.32 cfs 0.641 af

Pond 6P: POCKET WETLAND Peak Elev=841.50' Storage=8,536 cf Inflow=5.53 cfs 0.248 af
8.0" x 45.1' Culvert Outflow=1.03 cfs 0.243 af

Pond 7P: BASIN 2 Peak Elev=840.71' Storage=11,731 cf Inflow=8.12 cfs 0.953 af
15.0" x 40.0' Culvert Outflow=6.37 cfs 0.953 af

Link 8L: TOTAL POSTDEVELOPED Inflow=13.45 cfs 1.553 af
Primary=13.45 cfs 1.553 af

Total Runoff Area = 11.319 ac Runoff Volume = 1.557 af Average Runoff Depth = 1.65"
92.30% Pervious = 10.447 ac 7.70% Impervious = 0.872 ac

Summary for Subcatchment 2S: AREA TO BASIN 1

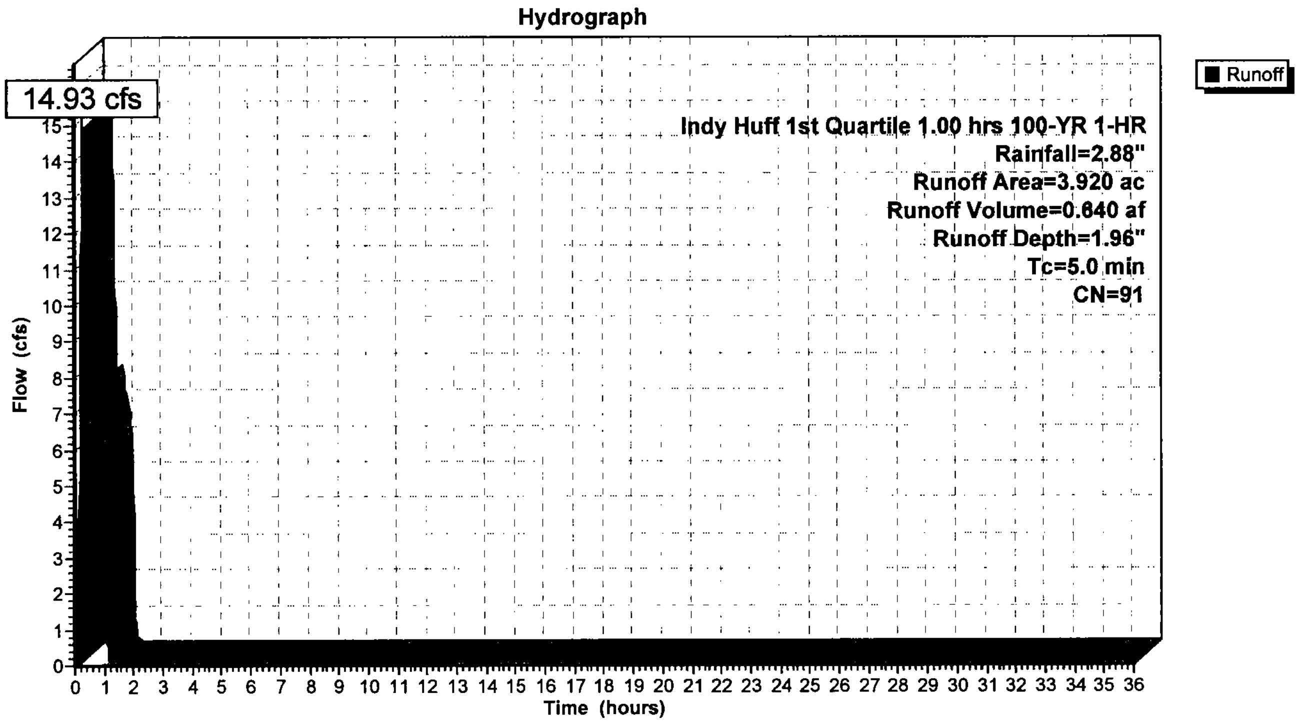
Runoff = 14.93 cfs @ 0.30 hrs, Volume= 0.640 af, Depth= 1.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 100-YR 1-HR Rainfall=2.88"

	Area (ac)	CN	Description
	0.737	98	Paved parking & roofs
	2.629	91	Gravel roads, HSG D
*	0.554	84	50-75% Grass Cover, Fair, HSG D
	3.920	91	Weighted Average
	3.183		Pervious Area
	0.737		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: AREA TO BASIN 1



Summary for Subcatchment 3S: AREA TO BASIN 2

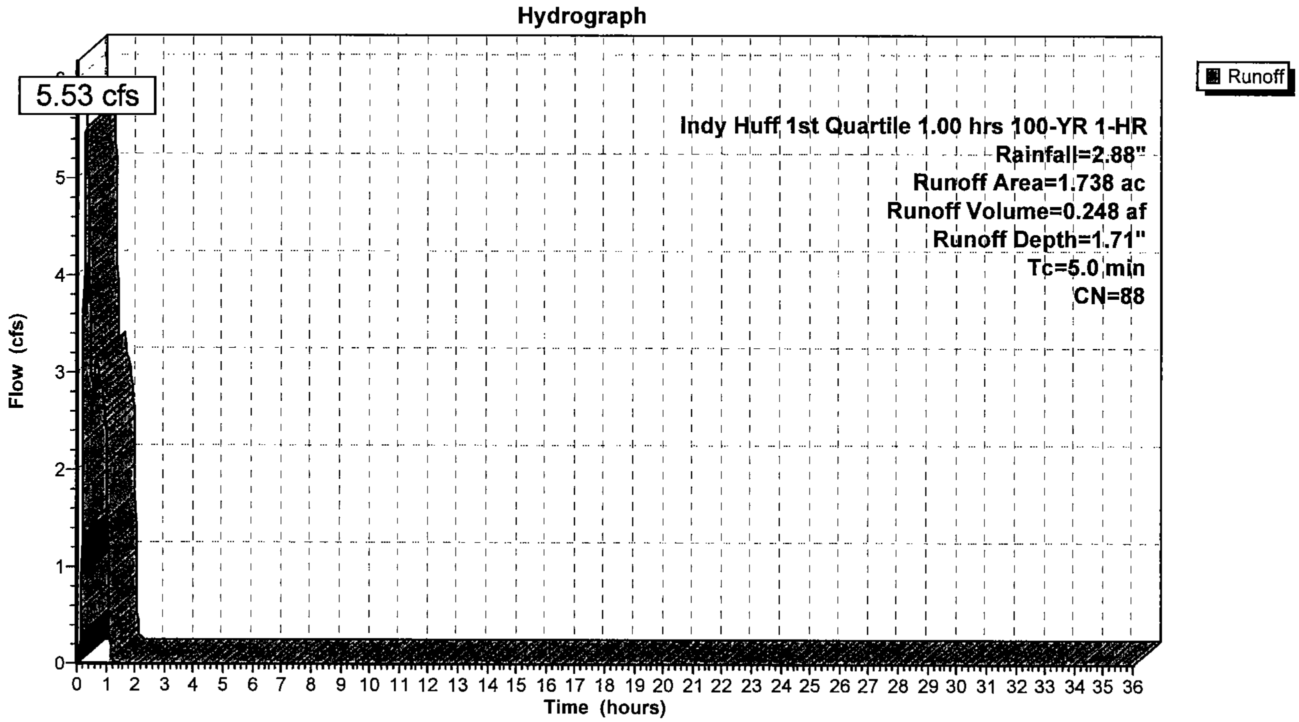
Runoff = 5.53 cfs @ 0.32 hrs, Volume= 0.248 af, Depth= 1.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 100-YR 1-HR Rainfall=2.88"

Area (ac)	CN	Description
0.055	98	Paved parking & roofs
0.888	84	50-75% Grass cover, Fair, HSG D
0.795	91	Gravel roads, HSG D
1.738	88	Weighted Average
1.683		Pervious Area
0.055		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: AREA TO BASIN 2



Summary for Subcatchment 4S: UNMANAGED AREA

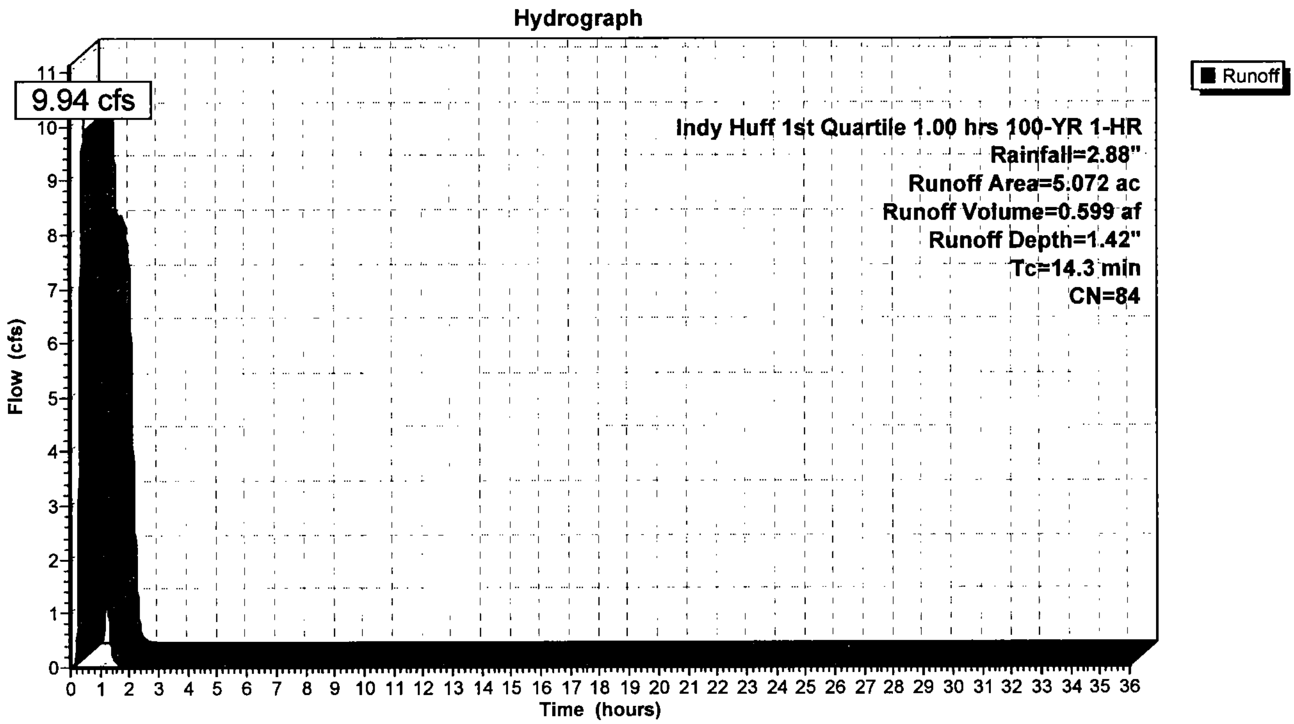
Runoff = 9.94 cfs @ 0.48 hrs, Volume= 0.599 af, Depth= 1.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 100-YR 1-HR Rainfall=2.88"

	Area (ac)	CN	Description
	3.435	84	50-75% Grass cover, Fair, HSG D
	0.671	91	Gravel roads, HSG D
	0.886	77	Woods, Good, HSG D
*	0.080	98	Paved Parking & Roads
	5.072	84	Weighted Average
	4.992		Pervious Area
	0.080		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry,**

Subcatchment 4S: UNMANAGED AREA



Summary for Subcatchment 9S: AREA TO BASIN 2

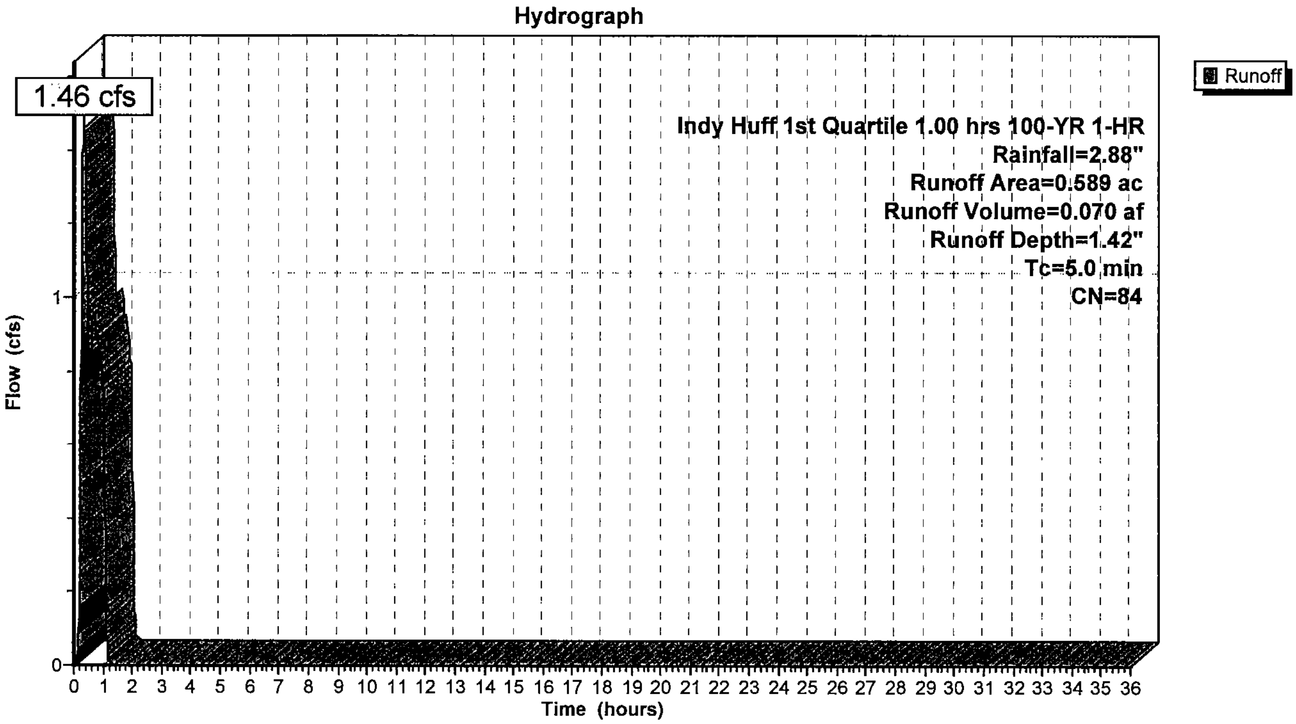
Runoff = 1.46 cfs @ 0.34 hrs, Volume= 0.070 af, Depth= 1.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 100-YR 1-HR Rainfall=2.88"

	Area (ac)	CN	Description
*	0.550	84	50-75% Grass Cover, Fair, HSG D
*	0.039	91	Gravel
	0.589	84	Weighted Average
	0.589		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: AREA TO BASIN 2



Summary for Pond 5P: BASIN 1

Inflow Area =	3.920 ac,	18.80% Impervious,	Inflow Depth = 1.96"	for 100-YR 1-HR event
Inflow =	14.93 cfs @	0.30 hrs, Volume=	0.640 af	
Outflow =	6.32 cfs @	0.93 hrs, Volume=	0.641 af,	Atten= 58%, Lag= 37.6 min
Primary =	6.32 cfs @	0.93 hrs, Volume=	0.641 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.95' @ 0.93 hrs Surf.Area= 17,759 sf Storage= 9,839 cf

Plug-Flow detention time= 20.5 min calculated for 0.640 af (100% of inflow)
Center-of-Mass det. time= 20.5 min (53.8 - 33.3)

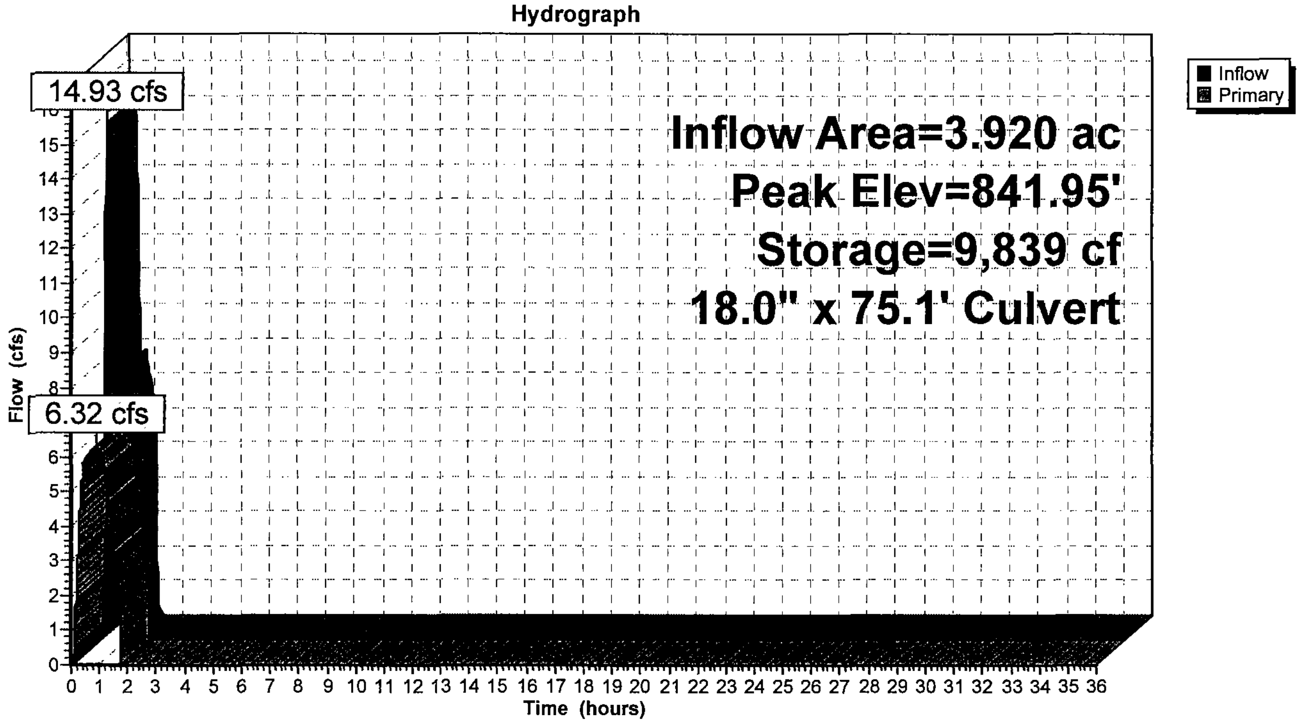
Volume	Invert	Avail.Storage	Storage Description
#1	841.00'	93,677 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
841.00	2,922	0	0
842.00	18,515	10,719	10,719
843.00	42,406	30,461	41,179
844.00	62,589	52,498	93,677

Device	Routing	Invert	Outlet Devices
#1	Primary	840.30'	**18.0" x 75.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.00' S= 0.0040 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=6.32 cfs @ 0.93 hrs HW=841.95' TW=840.52' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 6.32 cfs @ 4.05 fps)

Pond 5P: BASIN 1



Summary for Pond 6P: POCKET WETLAND

Inflow Area = 1.738 ac, 3.16% Impervious, Inflow Depth = 1.71" for 100-YR 1-HR event
Inflow = 5.53 cfs @ 0.32 hrs, Volume= 0.248 af
Outflow = 1.03 cfs @ 1.08 hrs, Volume= 0.243 af, Atten= 81%, Lag= 45.5 min
Primary = 1.03 cfs @ 1.08 hrs, Volume= 0.243 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.50' @ 1.08 hrs Surf.Area= 10,924 sf Storage= 8,536 cf

Plug-Flow detention time= 161.8 min calculated for 0.243 af (98% of inflow)
Center-of-Mass det. time= 161.8 min (196.3 - 34.5)

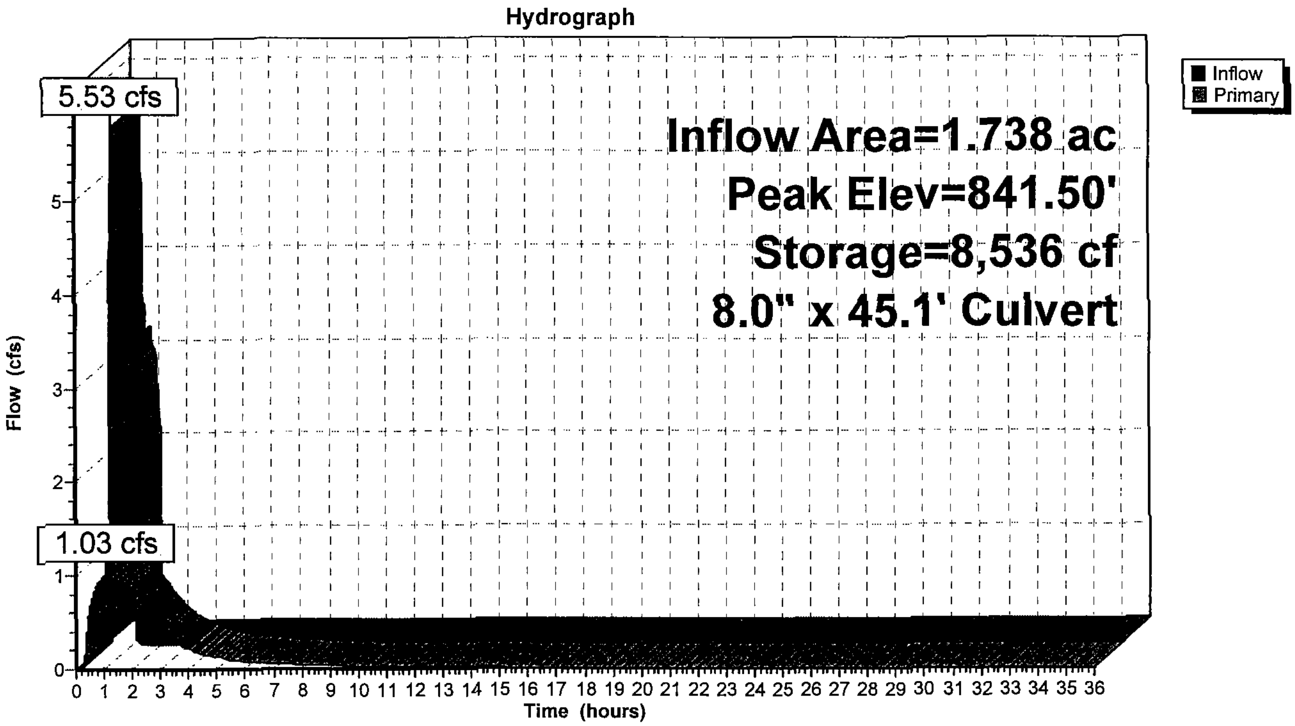
Volume	Invert	Avail.Storage	Storage Description
#1	840.50'	36,708 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
840.50	7,342	0	0
841.00	7,963	3,826	3,826
842.00	13,900	10,932	14,758
843.00	30,000	21,950	36,708

Device	Routing	Invert	Outlet Devices
#1	Primary	840.50'	**8.0" x 45.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.30' S= 0.0044 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=1.03 cfs @ 1.08 hrs HW=841.50' TW=840.67' (Dynamic Tailwater)
1=Culvert (Barrel Controls 1.03 cfs @ 2.94 fps)

Pond 6P: POCKET WETLAND



Summary for Pond 7P: BASIN 2

Inflow Area =	6.247 ac,	12.68% Impervious,	Inflow Depth > 1.83"	for 100-YR 1-HR event
Inflow =	8.12 cfs @	0.89 hrs, Volume=	0.953 af	
Outflow =	6.37 cfs @	1.21 hrs, Volume=	0.953 af, Atten= 22%,	Lag= 19.4 min
Primary =	6.37 cfs @	1.21 hrs, Volume=	0.953 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 840.71' @ 1.21 hrs Surf.Area= 7,198 sf Storage= 11,731 cf

Plug-Flow detention time= 32.0 min calculated for 0.953 af (100% of inflow)
Center-of-Mass det. time= 31.8 min (120.6 - 88.9)

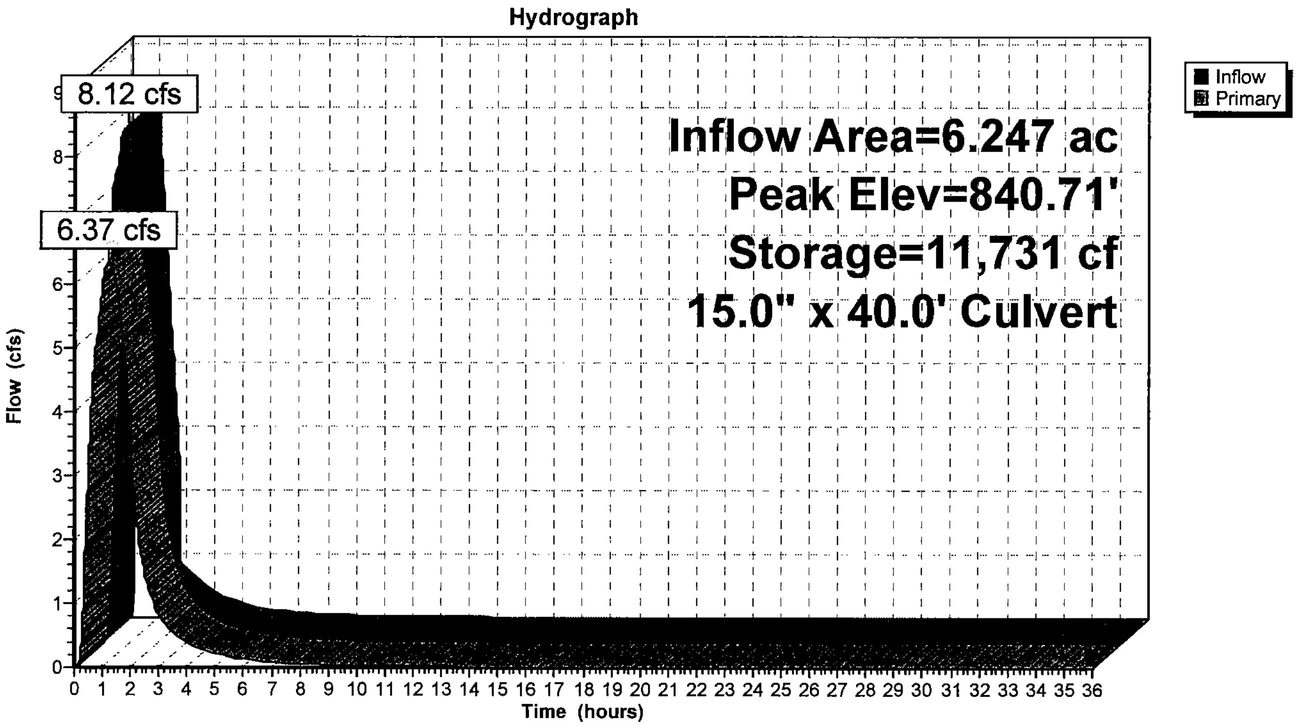
Volume	Invert	Avail.Storage	Storage Description
#1	838.70'	26,266 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
838.70	0	0	0
839.00	5,568	835	835
840.00	6,496	6,032	6,867
841.00	7,484	6,990	13,857
842.00	8,531	8,008	21,865
842.50	9,076	4,402	26,266

Device	Routing	Invert	Outlet Devices
#1	Primary	838.70'	**15.0" x 40.0' long Culvert** RCP, sq.cut end projecting, Ke= 0.500 Outlet Invert= 838.50' S= 0.0050 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=6.37 cfs @ 1.21 hrs HW=840.71' TW=0.00' (Dynamic Tailwater)
1=Culvert (Barrel Controls 6.37 cfs @ 5.19 fps)

Pond 7P: BASIN 2

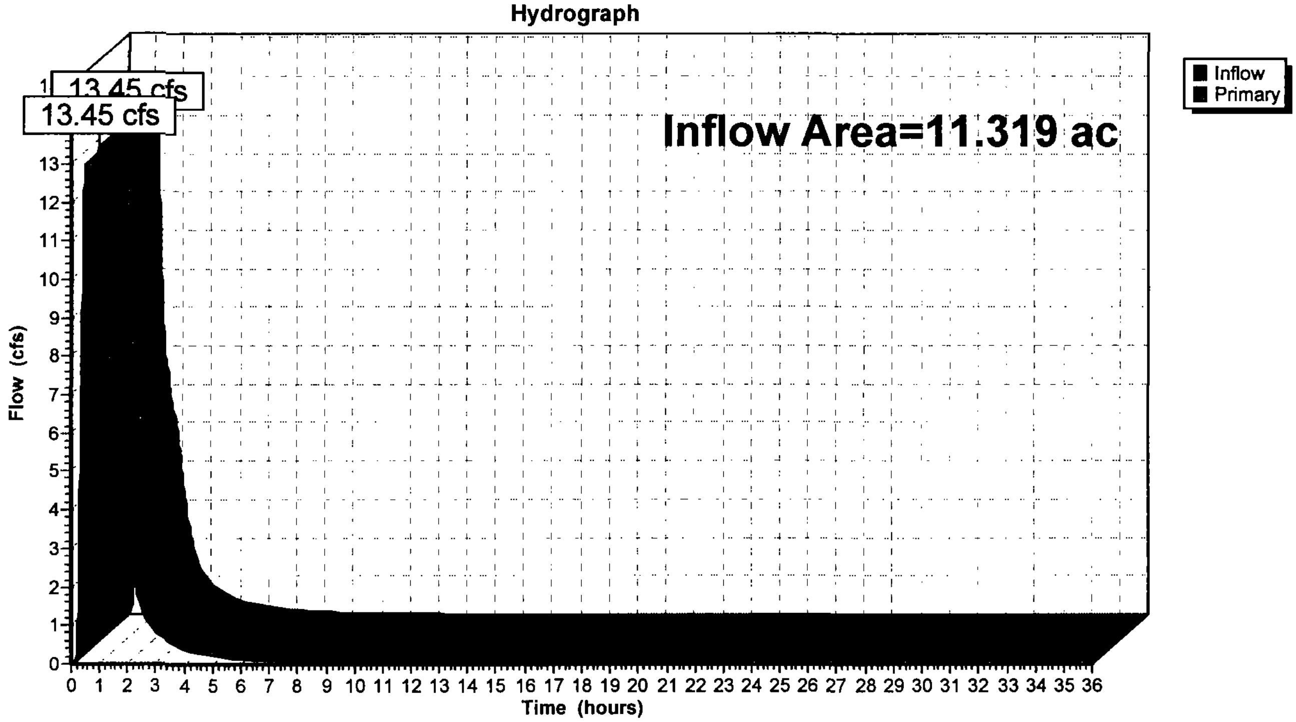


Summary for Link 8L: TOTAL POSTDEVELOPED

Inflow Area =	11.319 ac,	7.70% Impervious, Inflow Depth > 1.65"	for 100-YR 1-HR event
Inflow =	13.45 cfs @	0.97 hrs, Volume=	1.553 af
Primary =	13.45 cfs @	0.97 hrs, Volume=	1.553 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 8L: TOTAL POSTDEVELOPED



AMMENDED HYDROCAD STORM SUMMARY REPORTS
PROPOSED CONDITIONS

PAUL G. STRATMAN
REGISTERED
No. 19400368
STATE OF
INDIANA
PROFESSIONAL ENGINEER

7/24/15

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=4.06 cfs 0.361 af
Primary=4.06 cfs 0.361 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=2.22 cfs 1.168 af
Primary=2.22 cfs 1.168 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=2.01 cfs 0.103 af
Primary=2.01 cfs 0.103 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=3.34 cfs 0.530 af
Primary=3.34 cfs 0.530 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=2.04 cfs 1.352 af
Primary=2.04 cfs 1.352 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=2.82 cfs 0.638 af
Primary=2.82 cfs 0.638 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=3.56 cfs 0.216 af
Primary=3.56 cfs 0.216 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=2.33 cfs 0.851 af
Primary=2.33 cfs 0.851 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=8.40 cfs 0.837 af
Primary=8.40 cfs 0.837 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=4.10 cfs 2.151 af
Primary=4.10 cfs 2.151 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=5.74 cfs 0.297 af
Primary=5.74 cfs 0.297 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=7.01 cfs 1.170 af
Primary=7.01 cfs 1.170 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=3.31 cfs 2.558 af
Primary=3.31 cfs 2.558 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=6.40 cfs 1.359 af
Primary=6.40 cfs 1.359 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=8.30 cfs 0.550 af
Primary=8.30 cfs 0.550 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=5.32 cfs 1.749 af
Primary=5.32 cfs 1.749 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=10.43 cfs 1.100 af
Primary=10.43 cfs 1.100 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=5.06 cfs 2.666 af
Primary=5.06 cfs 2.666 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=8.04 cfs 0.416 af
Primary=8.04 cfs 0.416 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=8.77 cfs 1.488 af
Primary=8.77 cfs 1.488 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=4.04 cfs 3.187 af
Primary=4.04 cfs 3.187 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=8.20 cfs 1.725 af
Primary=8.20 cfs 1.725 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=10.89 cfs 0.743 af
Primary=10.89 cfs 0.743 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=6.63 cfs 2.152 af
Primary=6.63 cfs 2.152 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=13.45 cfs 1.553 af
Primary=13.45 cfs 1.553 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=6.59 cfs 3.511 af
Primary=6.59 cfs 3.511 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=11.73 cfs 0.604 af
Primary=11.73 cfs 0.604 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=12.38 cfs 2.068 af
Primary=12.38 cfs 2.068 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=5.24 cfs 4.258 af
Primary=5.24 cfs 4.258 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=11.32 cfs 2.383 af
Primary=11.32 cfs 2.383 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=14.80 cfs 1.054 af
Primary=14.80 cfs 1.054 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=9.05 cfs 2.929 af
Primary=9.05 cfs 2.929 af

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June 16, 2015 2003-1046-30

Ms. Tamara Ohl
United States Environmental Protection Agency
Corrective Action Section
Region 5
77 West Jackson Boulevard
Chicago, IL 60604-3590

RE: RMC- Beech Grove Project
Request for Amendment to Corrective Measures Design
Refined Metals Corporation
IND 000 718 130

Dear Tammy:

As you are aware, Refined Metals Corporation (RMC) has been implementing the approved Corrective Measures Design (CMD) for its former facility located in Beech Grove, Indiana. The Corrective Measures Implementation (CMI) work was initiated in August 2014 and was suspended in December 2014 due to the onset of winter weather. Simultaneously, the onsite containment cell reached the maximum capacity contemplated in the CMD. Additional excavation remains in areas where removal of impacted soil and debris exceeding the site specific standards was not completed. The means for completing the remediation of these impacted soils and debris is the subject of this document which is intended to serve as an amendment to the CMD.

OVERVIEW OF REQUEST TO AMMEND CMD

In 2014, the onsite soil excavation focused on the portions of the site designated by IDEM as Hazardous Waste Management Units (HWMUs). In many of these areas the excavation volume was significantly larger than anticipated by the CMD. The additional excavation was driven by the presence of debris such as battery casings, battery materials, posts, grids, and/or cinders/slag. The additional excavation also resulted from instances when post-excavation sample results exceeded the Preliminary Remediation Goals (PRGs) developed in the CMD; and additional soil removal was necessary. Because the excavation work performed to date resulted in a significantly increased volume, RMC and Advanced GeoServices placed a high priority on estimating the potential volume of soil and debris that still requires removal.

Based on a comparison of completed excavation against the horizontal and vertical extents identified in the CMD, a minimum volume of approximately 7,561 CY appears to require excavation. Advanced GeoServices and RMC have also performed a rigorous review of previously completed excavation depths in adjacent areas, test pit information, presence of debris, and historic soil data to identify a potential volume for "over excavation" beyond what is delineated in the CMD. We feel that the additional over excavation volume could be on the order of 2,100 CY to 5,700 CY (including concrete debris); resulting in a total volume of 9,700 CY to 13,300 CY requiring excavation.

Since suspending work in December 2014, RMC has evaluated multiple options to allow work to resume so that the corrective measures can be completed. RMC, Advanced GeoServices (Engineer/Environmental Consultant), and Op-Tech (Remedial Contractor) have determined that expansion of the onsite containment cell is the most practical way to accommodate the remaining volume of soils identified in the CMD for removal as well as additional over-excavation to remove debris and soil that exceeds the PRGs. Per our discussions with the USEPA and IDEM, all parties appear to be in agreement with the general concept of expanding the onsite containment cell. However, an explanation of significant differences (ESD) must be issued to formally approve the expansion of the containment cell.

The remainder of this document contains proposed amendments to the text, drawings, and figures that reflect work performed in 2014 as well as modifications proposed to amend the approved CMD in order to accommodate the additional excavation volume and expansion of the onsite containment cell. For purposes of discussion, the expanded portion of the onsite containment cell will be referred to as Containment Cell B (CCB). It should be noted that although the expanded portion of the Containment Cell is denoted as Containment Cell B, it is not a separate/discreet containment cell also located onsite, but merely an extension of the existing containment cell approximately 130 feet south.

This will provide additional waste storage capacity for up to 15,800 CY of soils using a maximum grading scenario (3:1 slope). Using a milder slope (approx. 8%) from the extended southern toe berm to the existing top of the south slope provides for a minimum storage capacity of approximately 10,600 CY of soils. If necessary the grade at a portion inset from the toe of the slope could be flattened to 3% to further decrease volume.

The following sections serve as proposed amendments to the approved CMD to reflect the resulting modifications required to construct the CCB. The format retains the section numbering used in the CMD. However, the text has been updated to reflect work performed in 2014 and a subsection is typically added to describe remaining work and proposed amendments to the work described in the CMD.

In addition to the amended CMD text that is presented below the following drawings are presented with revisions to reflect the currently anticipated CMI path and end result:

- Drawing 5A – Revision to drawing 5 of the CMD to depict CCB grading proposed for top of waste, bottom of cell, and final grades for minimum and maximum scenarios.

- Drawing 6A – Revision to drawing 6 of the CMD to depict the outline of completed HWMU excavations and an updated table to track 2014 excavation volumes and 2015 projections. The CCB footprint is extended over the HWMU areas to identify the areas that will be confirmed closed prior to CCB construction. Wells CC-6 and MW-2 are noted as "to be abandoned". CC-6A and MW-2A, replacement wells for CC-6 and MW-2 (respectively) are shown in proposed locations. MW-2D (Deep well) will also be abandoned, but will not be replaced.

- Drawing 7A – Revision to drawing 7 of the CMD with an updated table to track 2014 excavation volumes and remaining projections.

- Drawing 9A – Revision to drawing 9 of the CMD to depict site restoration with the CCB. Wetlands areas and Basin 2 are not affected by the expansion of CCB. Basin 1 was modified to provide the required storm water functions while minimizing the disturbance of the concrete slabs designated to remain in place.

- Table 1 of the Sampling and Analysis Plan presented in the CQAP. This table summarizes the proposed analysis and frequency for MNA and CC well networks. This table has been modified to reflect the proposed abandonment of MW-2 and CC-6, and the proposed installation of MW-2A and CC-6A.

AMMENDED CMD TEXT SECTIONS

3.3 CORRECTIVE MEASURES

The Corrective Measures activities related to soils and sediment to be completed under the purview of the USEPA are being performed specifically for lead. Within the off-site areas readily accessible by the general public, the remediation level for soil and sediment is 400 mg/kg total lead. On-site, soil remediation will be performed to achieve an area wide Preliminary Remediation Goal (PRG) of 920 mg/kg. For site wide groundwater, the standards will be 0.010 mg/L for arsenic and 0.042 mg/L for lead, the same values to be applied to groundwater for Closure of the lagoon. The site wide groundwater values were previously identified in the Phase II CMS Report as approved by USEPA.

The Final Decision issued by the USEPA determined that a commercial/industrial cleanup standard applies to the neighboring Citizens Gas property and agreed with RMC's interpretation that except for a drainage ditch along the north side of the Citizens Gas property and soil remediation outside the security fence parallel to Big Four Road, no remediation is required on that property and placement of a deed restriction is the only action required as part of the Corrective Measures. RMC is planning to perform the surface soil remediation during the Corrective Measures and HWMU Closure activities. However, Citizens Gas has previously completed some of the surface soil remediation associated with the deed restriction and may perform surface soil remediation in other remaining portions of its property prior to CMI work resuming.

Remediated soils generated from the Citizens Gas property as a result of work performed by RMC's remedial contractor will be consolidated in the containment cell. Remediated soils generated by work performed by Citizens Gas and its own contractors will be managed and disposed of by Citizens Gas.

Results of soil sampling conducted off-site are provided on Sheet 3 of the design drawings. A discussion of the results of the groundwater sampling conducted in conjunction with the RFI is provided in Section 4.5 of the CMD and is provided in Tables 1A through 1L. Sampling and evaluation of data being performed in relation to the Monitored Natural Attenuation (MNA) of lead and arsenic in groundwater are considered components of the RCRA Corrective Measure as they have been specified by the USEPA (rather than by IDEM as part of the HWMU closure), and are described in detail in the MNA Work Plan provided as Attachment H of the CMD.

With the exception of the expanded containment cell construction to accommodate increased soil volume there are no significant changes to the overall approach to remediation presented in the CMD. The CCB construction will require three (3) monitoring wells to be removed (MW-2, MW-2D, and CC-6). One of the new wells (MW-2A) will replace one of the wells in the MNA work plan. CC-6A will become part of the containment cell monitoring network. MW-2D will not be replaced.

5.4 CONTAINMENT CELL

Pursuant to the Statement of Basis issued by the USEPA, the containment cell is situated in the northwest corner of the Site and will extend south adjacent to the western boundary of the property. The containment cell will be defined by a perimeter soil berm, have a soil bottom and be capped with an impervious composite cap system. The composite cap will consist of (from top to bottom) a vegetative cover, erosion control mat, 6-inches of topsoil, 18 inches of compacted soil, double sided composite drainage net, 60-mil textured geomembrane and non-woven geotextile placed on a smooth, compacted soil subgrade. The drainage net will terminate in an anchor trench constructed in the perimeter soil berm. The anchor trench will contain a perforated pipe in a stone annulus designed to drain water from the drainage net to the surrounding ground surface. These general design components are unchanged from the approved CMD.

Cover soil sliding and interface stability calculations have been performed and are provided in Attachment C of the CMD. Those calculations have been performed for the "worst-case" slope condition based on the maximum cell grading (β = 33%, H=18 ft and L=54 ft for "steep" portion of slope) and an assumed minimum interface friction angles and soil unit weight (Φ=22° and σ =120 lb/ft^3). Collectively these values provide an interface factor of safety of 1.22. These are assumed values and must not be relied upon for final stability. As described in Specification Section 02751, interface friction testing ("shear box testing") must be performed utilizing the actual geosynthetic liner materials and cover soil fill proposed for use by the Contractor for cap construction. The shear box testing will be performed at confining pressures of 0.5, 1.5 and 3.0 psi for each interface (cover soil to geocomposite; geocomposite to textured geomembrane; textured geomembrane to geotextile; and geotextile to sub soil) and the result utilized to estimate the residual friction angles for each interface. If the results are less than 22°, the factor of safety will be less that 1.2 and the interface will be considered "unstable". If an unstable interface exists, RMC will have the option of requiring the Contractor to perform testing of alternate materials until acceptable interface friction values are achieved or modifying finished grading of the containment cell to attain the minimum required factor of safety.

The remedial contractor did perform this testing on the materials used for the construction of the Containment Cell. Satisfactory stability was demonstrated and the materials were approved for use.

As a result of the change in the containment cell location required by the Statement of Basis, sufficient space was made available in the CMD to allow an increase in the size of the cell foot print from approximately 1.15 acres to 1.32 acres (as measured at the anchor trench). At the maximum 3:1 grading shown on Sheet 5, cell capacity presented in the CMD was estimated to be approximately 21,490 cubic yards; the CMD anticipated that this would be a sufficient volume to accommodate all of the soil and sediment originally proposed for remediation as part of the Corrective Measures and HWMU Closure and still provide additional excess capacity for soils from the Citizens Gas property and/or additional material generated on-site as a result of additional excavation required to meet the site specific standards..

5.4.1 Containment Cell Expansion (CCB) Details

Because the excavation volume was larger than anticipated in the CMD, insufficient volume was available in the CMD containment cell design to accommodate all remediated soil and sediment. It is proposed that excess materials generated by the remaining soil remediation work be placed in an expanded cell footprint (the CCB) created by expanding the south slope of the original containment cell approximately 130-ft to the south. If the additional volume of CCB also proves insufficient, excess soils may be sent for off-site disposal in accordance with federal, state and local regulations. Excess soils with hazardous characteristics may be treated onsite using reagents to reduce the leaching ability of metals. RMC will obtain USEPA approval before beginning onsite treatment of soils and debris with hazardous characteristics.

Sheets 5A and 9A show the grading of the completed cap, including the CCB, for maximum (33% slope) and minimum required finished cap slopes (approx. 8% slope). The expanded CCB design will provide for a maximum additional capacity of approximately 15,800 CY of additional airspace in CCB (up to 37,300 CY total). A minimum grading scenario for CCB would create additional storage capacity for approximately 10,600 CY of material (32,100 CY total). It is estimated that between 9,700 to 13,300 CY of contaminated soil and debris remain.

The existing toe berm at the base of the containment cell will remain in place. A new toe berm will be constructed around the perimeter of the expanded CCB footprint on the south, east, and west slopes of the CCB. It is anticipated that the cell construction would proceed in a similar manner whether constructed to the minimum or maximum capacity scenario. Initially the material would be placed in the CCB to achieve the minimum capacity grading. Once that was achieved, the remaining volume of excavation could be reviewed to optimize the placement of remaining materials in the CCB. Any remaining soil and debris would be placed as needed to maintain the required slopes and construct the CCB in a stable manner. Fine grading would be performed prior to geosynthetic placement for any CCB capacity.

The intent for the new addition to the containment cell (CCB) is to tie-in to the existing geosyththetic layers installed on the existing containment cell. The remedial contractor will remove the cover soils presently in place on the south slope of the containment cell to allow access to the geosynthetic materials. The geosynthetic materials in place on the south slope will be completely removed and disposed of by placing the remove materials flat on the bottom of the CCB. The south slope of the existing waste subgrade will be benched to increase the stability of the new materials being placed into CCB.

Once soil removal and waste placement is completed the new geosynthetic materials will be installed on CCB and tied into the materials in place on the existing portions of the containment cell. The exact tie-in location will be determined in the field by the Installer. QC testing will be performed at the same rate specified in the original containment cell design. This will include destructive seam testing for the junction of the HDPE liner from the existing containment cell to the CCB. The toe berm around the base of the containment cell will be expanded south prior to the start of waste placement in CCB. The cap cover soil, toposoil, and turf establishment procedures for the CCB will remain the same as presented in the CMD for the original containment cell.

The proposed CCB will extend over HWMU's WP1A, WP2A, WP2B, WP1B, WP1C, WP1D, WP2C and MSB2A. Remediation has been completed in several of these areas. However, remediation has not been completed in portions of WP1A and WP2A, and WP2B. In the areas where excavation has not been completed, the remaining HWMU soils will be excavated, confirmatory sampling will be performed to ensure that impacted soils have been removed and the area will be backfilled to achieve the bottom elevation of the CCB (El. 841.5). Soil excavation will be completed in accordance to the details specified in section 6.5.1 of the CMD.

RMC will provide IDEM with a closure report (or equivalent details verifying closure) for the HWMU areas in which excavation was previously completed. Once the remaining HWMU excavations within the CCB footprint are believed to also be completed, an addendum to the closure report will be submitted to IDEM. Once IDEM has provided approval that the remediation standards for the HWMU areas within the CCB have been achieved, waste placement for CCB construction will begin.

5.5.2 MNA Groundwater Monitoring

The area of site groundwater that is the subject of MNA was determined based on the results of previous groundwater sampling, the hydrogeologic conceptual site model, and an understanding of the operating history of the facility. The groundwater monitoring wells to be included as part of the MNA groundwater monitoring network identified in the CMD consisted of MW-1, MW-2, MW-3, MW-8, MW-9, MW-12, and CC-1 through CC-6. These wells have been selected as they bound the MNA monitoring zone. At the request of the USEPA, MW-4 and MW-6 were added to the MNA groundwater monitoring network for a period of at least the first four (4) quarters of monitoring.

Existing wells MW-7 and MW-10 were not included as part of the proposed MNA sampling network because they were located in the prepared containment cell location and are proposed for abandonment as part of the proposed corrective measures. MW-7 and MW-10 were abandoned as part of the 2014 CMI work.

As summarized in Section 4, groundwater sampling has identified concentrations of arsenic > 10 ug/L in MW-1, MW-2, MW-3, MW-7, MW-8 and MW-10; and concentrations of lead >42 ug/L in MW-2 and 7. Pursuant to the Statement of Basis, RMC will conduct sampling at the designated wells for the purpose of determining if concentrations are increasing, decreasing or stable, and to collect data regarding groundwater parameters that directly impact groundwater geochemistry.

The MNA groundwater monitoring wells will be sampled beginning approximately one month following installation of the proposed containment cell monitoring wells. Sampling will be performed once every calendar quarter for twelve consecutive quarters with the first evaluation regarding future frequency performed after completion of the second year of monitoring (i.e., after 8 quarters). Monitoring will end when the sampling results demonstrate that the remedial goals have been attained for four consecutive quarters. During the first two quarterly groundwater sampling events, samples will be analyzed for total and dissolved arsenic and lead, sulfide, sulfate, nitrate arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), and manganese speciation (MnII/MnVII) for use in geochemical modeling. Beginning after the second quarterly groundwater sampling event, groundwater analysis will be limited to total and dissolved lead and arsenic. Field parameter readings to be recorded at the time of sample collection during all groundwater sampling events shall include temperature; pH; Eh; dissolved oxygen (DO); specific conductance and turbidity.

Detailed information regarding the proposed MNA activities is provided in the MNA Work Plan (Attachment H) to the CMD.

5.5.2.1 Adjustments to Groundwater Monitoring to Accommodate CCB

There are presently three (3) groundwater monitoring wells located within the proposed footprint of the CCB. This includes MW-2, MW-2D, and CC-6. All three will be abandoned in place. Before the start of remedial work in 2015, these wells will be abandoned using the same methods applied for the abandonment of MW-7 and MW-10 during the 2014 CMI. MW-2 and CC-6 are part of the current Containment Cell (CC) and MNA groundwater monitoring program and during the period prior to their abandonment they will be sampled at their required frequency in accordance with the monitoring plan presented in the CMD. All other wells that are part of the CC/MNA groundwater monitoring program will continue to be monitored during the remainder of the CMI work as described in the CMD (and above) during the construction of the CCB.

Well CC-1 is proximal to MW-2. Therefore CC-1 will continue to provide coverage near the NW corner of former waste pile #1. However, it is proposed that MW-2A be installed offset from the southwest corner of CCB (approximately 10 feet from the berm) to provide for monitoring of groundwater around the southwest corner of the containment cell. When CC-6 is abandoned there will be no other well to provide coverage for the south central/eastern portion of the containment cell. CC-6A will be installed on the south side of CCB (approximately 10 feet from the berm).

MW-2A will be incorporated into the MNA Monitoring well network for the same sampling parameters and frequency as other MNA wells. CC-6A will be incorporated into the CC network for sampling parameters and frequency. The new wells will be sampled during the next quarterly sampling event that occurs at least one month following the completion of development of the proposed new CCB monitoring wells. The CC monitoring well sampling program is summarized on Table 1 of the Sampling and Analysis Plan summarizes the CC and MNA Groundwater Monitoring analytes and frequency presented in the CMD Attachments. Table 1 has been modified to reflect the previous requests by USEPA and proposed future modifications as a result of the CCB construction and is attached to this submission.

6.3 CONTAINMENT CELL CONSTRUCTION

The containment cell was constructed in 2014 in accordance with the approved CMD. It is situated in the northwest corner of the Site, as shown on Sheet 5 of the CMD drawings. The containment cell is L-shaped with an area of approximately 56,740 square feet as defined by the centerline of an 8-feet wide (top) earthen berm. The berm was constructed with a top of berm elevation of 843.0 and an interior bottom elevation of 841.5.

A review of potentiometric groundwater levels collected at MW-10 since installation in 2003 indicated that the groundwater elevation within the vicinity of the proposed containment cell has varied between 833.24 (October 2007) and 841.25 (April 2005) standing water has been noted in the vicinity of MW-10 after precipitation events. Based on a direct comparison, this means the groundwater has ranged from 8.26 feet below to 0.25 feet below the proposed cell bottom elevation. Following completion of proposed grading and drainage features, the minimum vertical separation is expected to be at least 2.0 feet based on a maximum possible surface water elevation in the wetlands of 839.5. In addition, the impermeable barrier created by the cap essentially eliminates infiltration beneath the cap footprint. Similar groundwater elevations and conditions are expected to be present within the CCB footprint. High or perched groundwater was not observed within the containment cell bottom during 2014 CMI efforts and is not expected to present issues in 2015 during CCB construction.

The existing containment cell was constructed using the maximum proposed finished grades of 3 horizontal to 1 vertical (33%) on the slopes; and not flatter than 33 horizontal to 1 vertical (3%) on the top. The maximum elevation of the top of cap is 862.5 +/-. The maximum grading shown on Sheet 5 of the CMD drawings for the top of waste and top of cap was utilized and represents a maximum filling configuration which provided a waste disposal capacity of approximately 21,490 cubic yards. The total combined volume of soil, sediment and miscellaneous debris contemplated for excavation in the CMD was approximately 20,480 cubic yards. This estimate accounted for approximately 5,300 cy of soil from the HWMUs, approximately 6,200 cy of soil from other on-site areas, approximately 5,000 cy of on-site debris, approximately 2,000 cy of off-site soil and sediment, and approximately 1,980 cy of material from Citizens Gas. As shown on Drawing 6A, it is estimated that over 15,000 CY of material was generated from just the HWMU excavations in 2014.

The western side of the containment cell berm is located 50 feet from the western property boundary as measured from the centerline of the proposed berm. The area between the berm and west property line is utilized to accommodate a perimeter access road and swale. The access road to be constructed will provide access for sampling the proposed groundwater monitoring wells and maintaining the swale. The swale will collect runoff from the west section of the containment cell cap and convey it to the adjacent existing wetlands. The northern portions of the cap will drain directly to existing wetlands to the north and east of the cap. The southern portion of the cap and the southern portion of the Site will drain to a stormwater management basin south of the containment cell. The eastern portion of the cap will drain to a stormwater management basin east of the containment cell. The eastern portion of the Site drains to a proposed pocket wetland for water quality management. The pocket wetland then discharges north to the stormwater management basin east of the containment cell. The invert elevation of the lowest outlet device for the basin east of the containment cell will be 838.70. Wetlands are expected to be inundated during seasonally wet periods, although the maximum standing water level in the wetlands will be 839.50 as controlled by the spillway proposed between the wetlands and drainage ditch along the CSX train track.

Construction of the existing containment cell required minor cutting and filling to create the swale, berm and access road. Existing groundwater monitoring wells MW-7 and MW-10 have been abandoned by RMC prior to the start of Corrective Measures construction. Existing trees have been cleared and grubbed from the containment cell area.

General procedures for stockpile sampling are provided in the Sampling and Analysis Plan portion of the Construction Quality Assurance Plan (Attachment D). Stockpile samples were (and will be) analyzed for lead, arsenic, antimony, cadmium and selenium (Method 6010). Analytical results for arsenic, antimony, cadmium and selenium will be compared against the soil standards listed for HWMU Closure in Section 5.3 of the CM Design Report. Lead will be compared against the 920 mg/kg PRG calculated by the BHHRA and the 400 mg/kg residential soil screening value being used for lead in soil within the public and railroad right of way. Stockpiles with results below the HWMU soil standards for arsenic, antimony, cadmium and selenium and less than 400 mg/kg lead can be utilized as backfill anywhere on-site. Stockpiles with results below the HWMU soil standards for arsenic, antimony, cadmium and selenium and between 400 mg/kg and 920 mg/kg total lead can be utilized as backfill anywhere on-site except within drainage features, the storm water management basin. Such material may not be used on public road and railroad right-of-ways. Stockpiles with results that exceed the HWMU soil standards for arsenic, antimony, cadmium and/or selenium or have >920 mg/kg lead will be placed in the containment cell or sent off-site for disposal.

Containment cell filling has (and will be) performed in lifts. Lifts will have a maximum loose lift thickness of 18-inches and each lift will be compacted until visually stable as determined by the QA Representative. Filling will be sequenced to contain storm water runoff from the exposed waste surface and the contractor will be required to collect and treat standing water prior to placement of subsequent lifts. Access into the cell will be provided from the south end and equipment entering the cell and running across areas of exposed soil will be required to clean the wheels before exiting the cell.

6.3.1 Containment Cell B Construction

As discussed in Section 5.4.1, it is proposed that the onsite containment cell be expanded to accommodate the additional volume of contaminated soils encountered during the CMI work in 2014. The remaining soils in the HWMU areas will be removed, and confirmatory sampling performed. Once the PRGs are achieved, the areas will be backfilled to the proposed subgrade elevations. The containment cell berm will be constructed around the perimeter of the proposed CCB prior to excavation of other areas and placement of the contaminated soils within the CCB footprint.

The existing toe berm at the base of the containment cell will remain in place. A new toe berm will be constructed around the perimeter of the expanded CCB footprint on the south, east, and west slopes of the CCB. To prepare the containment cell south slope for expansion, the existing cap cover soils will be removed and stockpiled exposing the geocomposite drainage layer. These soils may be used as fill in excavation areas, or reused as cap cover soils. The exact method to expose and fold back the geosynthetics that will remain will be agreed upon between the Installer and the QA representative. It is anticipated that the existing geomembrane will be cut near the top of the current slope so that the new seam is on the "flat" (3% slope or less) portion of the CCB cell.

The previously installed geosynthetics that remain in place on the other slopes of the containment cell will be protected against weather and construction traffic. Soil berms or filter socks will be constructed around the opening in the containment cell to divert stormwater from entering the opening and infiltrating into the containment cell contaminated soil. The tie-in will be created in a location to minimize surface infiltration. If the geosynthetics are damaged during the liner tie-in process, repairs by the Installer will be made accordingly.

The filling of the CCB will be performed in horizontal lifts. Soil lifts will have a maximum loose lift thickness of 18-inches and each lift will be compacted until visually stable as determined by the QA representative. Filling will be sequenced to contain storm water runoff from the exposed waste surface and the contractor will be required to collect and treat standing water prior to placement of subsequent lifts.

6.7 CONTAINMENT CELL CAPPING AND CLOSURE

The final grading of the CMD cap is dictated by the actual volume of soil, sediment and debris placed, and the results of interface friction testing for the selected cap geosynthetic and soil materials. The maximum grading shown on Sheet 5 of the CMD drawings was used to construct the containment cell in 2014. The maximum slopes used are 33%. As filling progresses to elevations above the top of berm, temporary diversions are used to intercept storm water runoff from the exposed materials in the cell and convey that water to the temporary treatment system for processing. When final grades were reached, the finished surface was smooth graded, rolled and protruding rocks or other objects that could puncture the geomembrane will be remove by the Contractor. Following approval of the finished surface by the QA Representative, the Contractor protected the area against vehicular traffic except when necessary to deploy the liner components. Any damage to the approved surface was repaired by the Contractor to the satisfaction of the QA Representative prior to geomembrane placement. Although not utilized in 2014, if necessary the approved surface could have been temporarily covered with plastic sheeting or non-woven geotextile until mobilization of the liner installer, provided such measures protect the surface against erosion. Any such temporary cover would require ballast or other means to adequately balance it to protect against disturbance by wind or other causes.

The CMD cap utilizes a non-woven geotextile placed directly on the approved soil surface, a textured 60 mil HDPE geomembrane (Cap Barrier Layer); double sided drainage net (Cap Drainage Layer); and18-inches of compacted soil fill. As part of the 2015 work, 6-inches of topsoil; erosion control mat; and vegetative cover will be placed on all CMD cap slopes, including those constructed in 2014. The geomembrane and drainage net components of the cap terminate in an anchor trench in the top of the toe berm. Infiltrating precipitation intercepted by the drainage net will be collected in a perforated pipe situated within the anchor trench. The perforated pipe will have outfalls periodically around the perimeter of the berm to discharge collected water. Specification Section 02751 provides requirements the Cap Drainage Layer; and Section 02755 provides requirements for the Cap Barrier Layer.

6.7.1 Containment Cell B Capping and Closure

The grading of the CCB is designed to have a maximum slope of no more than 3:1 but final grades will be determined by the final volume of soil and debris that is excavated and placed in the CCB. Interface friction testing has previously been performed to ensure the geosynthetics installed will work with the site soils and design parameters. During CCB construction, the Contractor will maintain and treat stormwater within the cap footprint so that contaminated stormwater does not cross contaminate other areas around the site. The cap construction for the CCB will be performed in the same manner as the containment cell as described in Section 6.7 of the CMD.

The soil and debris placed into the CCB will be added to the south slope of the containment cell by removing all geosynthetic materials from the south slope and new waste is benched into the existing material that makes up the south slope of the original containment cell.

The proposed method will ensure a stable transition between existing and expanded portion of the cap. The existing toe berm at the base of the containment cell will remain in place. A new toe berm will be constructed around the perimeter of the expanded CCB footprint on the south, east, and west slopes of the CCB. In general, the placement of waste to construct the CCB will be the same as the methods described in the CMD that were used to construct the original containment cell.

6.8.2 Containment Cell Exterior Berms, Drainage Swale and Access Road

The sequence of construction presented in the CMD included the construction of exterior berms, access road and drainage features prior to the start of site-wide and off-site remediation activities. The access road around the containment cell was not constructed in 2014, but will be constructed through cutting and filling with structural soil fill following the procedures provided in Specification Section 02210, to achieve a completed stable subgrade surface. The access road will have a cross-slope directing surface water runoff from the road to the proposed drainage swale. The access road surface will be stabilized utilizing geotextile fabric and On-Site Surface Stone Aggregate per Specification Section 02936.

The drainage ditch along the west side of the containment cell and the outside face of the east, west and south containment cell berms was partially constructed in 2014, but was not restored. It will be restored using sod installed in accordance with the requirements of Specification Section 02936. The drainage ditch along the west side of the containment cell will be constructed with an underdrain as required by the City of Indianapolis for drainage ditches with a centerline slope <1.0%. The underdrain will be constructed as shown on the detail on Sheet 12 of the design drawings, and will daylight into the wetlands north of the containment cell. The drainage swale to the west of the CCB would be extended farther south to retain the ability to direct stormwater that will be collected farther South due to the proposed footprint of the CCB.

6.9 SITE DEED RESTRICTION

The CMD anticipated that upon completion of site soil and sediment remediation and associated restoration, RMC will record a restriction on the deed for the RMC property. The deed restriction will restrict the use of the property to only commercial/industrial land use, and prevent installation of on-site potable groundwater wells. No change to this approach is proposed.

The deed restriction will also prohibit any activities that impact the integrity of the containment cell cap, sidewalls, and berm.

7.0 PERMITTING REQUIREMENTS

This section describes federal, state, regional, and local permits and approvals required for implementation of Corrective Measures. This section also discusses site access and easement agreements or other arrangements with adjoining landowners necessary for implementation of Corrective Measures. A discussion of the application requirements and timeline for each item is provided below.

7.1 FEDERAL PERMITS

Army Corps of Engineers Nationwide Permit for Cleanup of Hazardous and Toxic Waste (NP-38) is required for the proposed wetland disturbance and work in the drainage ditches along the railroad track and spur. The NP-38 was obtained prior to submitting the IDEM Rule 5 application. The NP-38 application included the following:

- Application for Department of the Army Permit
- Pre-Construction Notification for Use of Nationwide Permit 38
- Wetland Delineation Report
- Jurisdictional Determination
- Wetland Mitigation Narrative
- Notification letters
- Drawings

Prior to the start of the 2014 CMI, the Army Corps of Engineers was provided with an updated version of Drawing 8 of the CMD. Since the wetlands disturbance associated with the CMI will not be changing as a result of the CCB, no permit modification is necessary. Army Corps of Engineers will be provided with a copy of Drawing 9A of this CMD addendum for reference.

7.2 STATE PERMITS

7.2.1 Rule 5 – General National Pollutant Discharge Elimination System (NPDES) Permit for Storm Water Run-off Associated with Construction Activity

Indiana Administrative Code Rule 5 (327 IAC 15-5) is a performance-based regulation designed to reduce pollutants that are associated with construction and/or land disturbing activities. The requirements of Rule 5 apply to all persons who are involved in construction activity (which includes clearing, grading, excavation and other land disturbing activities) that results in the disturbance of one (1) acre or more of total land area.

RMC submitted application under Rule 5, which included the following:

- Notice of Intent (NOI) Letter
- Construction Plan
  - Project Narrative and supporting documents
  - Vicinity Map
  - Existing Project Site Layout
  - Final Project Site Layout
  - Grading Plan
  - Drainage Plan
  - Storm Water Pollution Prevention Plan
  - Post Construction Storm Water Pollution Prevention Plan

RMC has contacted IDEM and based on that discussion, will submit a revised NOI letter/form and associated documents as needed to extend duration of the Rule 5 permit.

7.3 CITY OF INDIANAPOLIS PERMITS

7.3.1 Office of Code Enforcement

7.3.1.1 **Drainage**

The Office of Code Enforcement (Office) requires that land alterations be compliant with standards and practices that result in proper storm water drainage and sediment control. The Office has indicated through conversation with Advanced GeoServices that a Mass Earthwork Permit may apply for Corrective Measures. The Mass Earthwork Permit is a drainage permit for projects involving earth disturbance without the construction of buildings. RMC obtained this permit during the 2014 CMI. However, the grading changes associated with the CCB construction will necessitate submission of revisions to the permit application. RMC has contacted the Office and was advised that only revised documents must be provided. This includes:

- Storm water permit application
- Revised copies of storm water plans
- Sediment and erosion control plan
- BMP operation and maintenance manual

Once construction resumes, the Remedial Contractor will continue to be responsible for informing and/or notifying the Office's observer assigned to the following:

- Daily work schedule including any changes in schedule
- Prior notification if work is to be performed on weekends and/or holidays
- Date mandrel tests are to be performed
- Date 'as-built' verification is to be performed

The Office, upon request of the Remedial Contractor and/or RMC, will schedule the final inspection.

7.3.1.2 **Improvement Location Permit**

Temporary office trailers will be required to support Corrective Measures activities. A permit will not be required for these trailers as the Office designates "movable, temporary use structures or buildings utilized during construction projects" as specific exemptions that do not necessitate an Improvement Location Permit. However, the Office stipulates that all provisions and regulations of the City of Indianapolis Industrial Districts Zoning Ordinance shall continue to apply to exempted structures and improvements. In 2014 the City of Indianapolis ruled that an Improvement Location Permit was not needed for the CMI work.

7.3.1.3 **Right-of-Way Permit**

RMC and/or the Contractor will submit/renew application for excavation within the South Arlington Avenue public right-of-way which will include, at a minimum, the following:

- A properly executed permit application, in the form designated by the Marion County Department of Code Enforcement Department (the Department), including but not limited to, the following information:
  - The name and address of the Remedial Contractor;
  - The nature of, and the reason for, the work to be performed;
  - The location of the worksite and the dimensions of the excavation;
  - The anticipated length of time to complete the work;

  - The method of traffic control to be used by the applicant at the worksite;
  - An indemnification agreement; and,
  - Any other pertinent information requested by the Department.

- A general liability insurance policy.
- A performance and maintenance bond.
- Approval from the Department if the proposed work involves a sanitary sewer, storm sewer, affects drainage within the public right-of-way, or as required.

The Remedial Contractor will be required to update the Right-of-Way Permit for the soil excavations along Arlington Avenue.

7.3.2 Department of Metropolitan Development

7.3.2.1 **Industrial Districts Zoning Ordinance**

The Site is designated as an I-3-S Medium Industrial Suburban District and I-4-S Heavy Industrial Suburban District and the Official Thoroughfare Plan for Marion County designates South Arlington Avenue as a Primary Arterial. The proposed containment cell will fall in both the I-3-S and I-4-S zoning districts. Although not representing a "structure" as defined under the zoning regulations, the cell has been situated to provide 30 feet of set back from the north and west property lines which represent the side and back yards of the property respectively. The setback from South Arlington Avenue, as measured from the centerline of the proposed berm will be approximately 246 feet at its closest point. The areas within the setbacks will be utilized as storm drainage and storm water management controls.

The containment cell does not appear to represent a "use" under the Industrial Zoning Ordinances, although both zoning districts include provisions for "industrial waste disposal facilities." The Performance Standards for both districts state that plans and specifications for proposed industrial waste disposal facilities shall be submitted to, and written approval obtained from, IDEM and the City of Indianapolis, Division of Compliance before an Improvement Location Permit will be issued. The final CMD was be submitted to the City of Indianapolis division of Compliance for written approval. In 2014 the City of Indianapolis ruled that an Improvement Location Permit was not required.

7.4 CITY OF BEECH GROVE PERMITS

Conversations with the City of Beech Grove and the City of Indianapolis indicate that, due to the nature of corrective measures, jurisdiction of the majority of work to be performed will be with the City of Indianapolis, Division of Compliance. No permits are expected to be required except for temporary facilities mobilized for completion of the work, although the City was provided copies of the Final CM Design to confirm the representations made during the initial conversations. If any conditions change with respect to permitting with the City of Beech Grove, an application will be submitted to the City of Beech Grove for the temporary office trailer.

9.0 SCHEDULE AND COST ESTIMATE

9.1 SCHEDULE

The additional remedial work to be completed is anticipated to take place over approximately 12 weeks (3 months). This work includes completion of the excavation work, the containment cell expansion, and the site restoration work. Assuming that the ESD is issued in mid August, RMC anticipates that the Contractor will mobilize in mid-late July and resume CMI work that is not directly tied to the CCB and associated ESD.

RMC intends to generate a closure report for the completed HWMU areas that will be submitted to IDEM in late June or early July so that it can be reviewed and approved prior to construction of the CCB.

9.2 COST ESTIMATE

Based on the remaining quantity of CMI work that is not yet completed and additional work associated with the CCB expansion and unit pricing from RMC's remedial contractor, it is estimated that the cost to complete the CMI in 2015 is approximately $1.1 – 1.3 million.

The CMD indicated an estimated present worth of the operations and maintenance costs for a period of 30 years. This is not likely to be changed as a result of the CCB construction.

10.0 POST CORRECTIVE MEASURES STORM WATER MANAGEMENT

This section of the CMD was last revised in a May 2014 letter to the USEPA. The proposed CCB expansion will cover a portion of the area previously designated for construction of Basin 1. Basin 1 has been reconfigured as shown on Drawing 9A. This configuration will minimize the disruption of the existing concrete slab that is intended to remain in place. The footprint of Basin 2 and the wetlands is largely unchanged. The spill way elevations were corrected as needed to satisfy the detention requirements.

Post corrective measures storm water management has been designed to comply with the *City of Indianapolis Stormwater Specifications Manual*. Section 302.03 of that document indicates that an increase in run-off volume is acceptable provided that sufficient detention/retention is provided to reduce the runoff flow (discharge rate). The required detention is as follows:

- 2-yr storm: $Q_{2proposed} \leq 0.5\ Q_{2existing}$
- 10-yr storm: $Q_{10proposed} \leq 0.5\ Q_{10existing}$

- 25-yr storm: $Q_{25proposed} \leq 0.75\ Q_{10existing}$
- 100-yr storm: $Q_{100proposed} \leq Q_{10existing}$

A comparison of existing and proposed conditions (based on 1-hr storm duration) is provided in the following table:

Condition	Existing, $_e$	Proposed, $_p$	Difference
Runoff Area (acre)	11.2	10.25	92%
Pervious Area (acre)	5.7	9.46	166%
Impervious Area (acre)	5.4	0.79	15%
V_2 2-yr Runoff Volume (acre-ft)	0.38	0.33	87%
Q_2 2-yr Runoff Flow (cfs)	8.6	3.56	41%
V_{10} 10-yr Runoff Volume (acre-ft)	0.87	0.78	89%
Q_{10} 10-yr Runoff Flow (cfs)	20.2	7.38	37%
V_{25} 25-yr Runoff Volume (acre-ft)	1.14	1.00	88%
Q_{25} 25-yr Runoff Flow (cfs)	27.2	9.11	33%
V_{100} 100-yr Runoff Volume (acre-ft)	1.59	1.40	88%
Q_{100} 100-yr Runoff Flow (cfs)	39.2	11.70	30%

The run-off area for the proposed conditions does not change significantly from the existing conditions. However, the proposed conditions indicate a significant reduction in impervious area. Supplemental drawing DA-01 depicts the existing runoff area; DA-02 depicts the proposed runoff area. HydroCAD results indicate that proposed run-off volume will be slightly larger than the existing conditions, but the basins and other stormwater management features provide more than adequate retention to satisfy the requirements of the City of Indianapolis.

As shown on Sheet 9A, the post corrective measures storm water management will consist of a gravity storm water system that will convey storm water runoff from the former impervious manufacturing areas of the site and the southern and eastern portion of the proposed containment cell cap through storm water management basins situated along the south and east sides of the proposed containment cell.

The south storm water management basin (Basin 1) will cover approximately 1.4 acres and have a maximum storage capacity of approximately 93,677 cubic feet before reaching the emergency spillway. The calculated storage volume for the 100 year design storm event is approximately 9,839 cubic feet. The outlet structure will be a 12-inch diameter corrugated polyethylene pipe with an invert elevation of 840.30 that discharges to the east storm water management basin (Basin 2).

Runoff from the eastern portion of the Site enters the sediment forebay and pocket wetland prior to discharge to the Basin 2. The pocket wetland will cover approximately 14,000 sf. The outlet structure for the pocket wetland will be a 12-inch diameter CPE pipe. The Basin 2 will cover approximately 0.2 acres and have a maximum storage capacity of approximately 26,266 cubic feet before reaching the emergency spillway. The calculated storage volume for the 100 year design storm event is approximately 11.731 cubic feet. The primary outlet device for Basin 2 will be three (3) parallel 12-inch diameter pipes that discharge to a wetland mitigation area within a swale conveying flow to the existing drainage channel. The wetland mitigation area is approximately 7,000 sf. The proposed discharge towards the north coincides with the original storm water discharge for the manufacturing areas of the site prior to construction of the storm water collection and treatment system.

Grading and underdrains will convey the storm water runoff from the restored areas of the site to the storm water management basins, as shown on Sheet 9A. The total drainage area to the basins is 10.25 acres with an average CN value of 90. HydroCAD® was utilized to perform the storm water management calculations following the SCS TR-20 Method. As presented on the calculations (Attachment C), the south basin (Basin 1) will detain a 1-hr storm event and attenuate the flows as follows:

DESIGN STORM RETURN	INFLOW (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	STORAGE (cf)
2	3.57	2.44	841.218	806
10	8.13	4.27	841.55	3,909
25	10.64	5.11	841.71	5,945
100	14.93	6.32	841.95	9,839

The east basin (Basin 2) will detain a 1-hr storm event and attenuate the flows as follows:

DESIGN STORM RETURN	INFLOW (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	STORAGE (cf)
2	2.77	2.22	839.57	4,144
10	5.32	4.37	840.06	7,284
25	6.51	5.13	840.32	8,975
100	8.12	6.37	840.17	11,731

<u>CMD ATTACHMENTS</u>

On the whole we do not feel that CCB will affect significant changes to any of the CMD Attachments. However, some additional consideration has been given to the following sections.

Attachment C – Design Calculations: has been amended to include estimates of remaining excavation volume and CCB capacity calculations. Revised stormwater calculations are provided with this document to reflect the modified drainage conditions that resulted due to CCB construction.

Attachment D – Construction Quality Assurance Plan (CQAP): A modified version of Table 1 of the Sampling and Analysis Plan (SAP) in Appendix D is attached to this document to summarize the MNA and Containment Cell groundwater monitoring network sampling requirements. The primary modifications are the inclusion of MW-4 and MW-6 to the MNA network per USEPA request and the substitution of well MW-2A to replace MW-2 once the CCB is built; and CC-6A to replace CC-6 once the CCB is built. This affects sections 5.6, 5.7, and Table 1. We do not feel that generation of an amended CQAP is necessary at this time.

Attachment E – Operation and Maintenance Plan: No significant changes to the Operation and Maintenance Plan are necessary as a result of the CCB construction. The same inspections of cap integrity and erosion conditions are applicable to the CCB. As with Attachment D, the primary modifications are the substitution of well MW-2A to replace MW-2 once the CCB is built; and CC-6A to replace CC-6 once the CCB is built. This affects sections 4.2. We do not feel that generation of an amended O&M plan is necessary at this time.

Attachment H – Monitored Natural Attenuation (MNA) Work Plan: A modified version of Table 1 of the Sampling and Analysis Plan (SAP) in Appendix D is attached to this document to summarize the MNA and Containment Cell groundwater monitoring network sampling requirements. The primary modifications are the inclusion of MW-4 and MW-6 to the MNA network per USEPA request and the substitution of well MW-2A to replace MW-2 once the CCB is built; and CC-6A to replace CC-6 once the CCB is built. This affects section 5.2. We do not feel that generation of an amended MNA work plan is necessary at this time.

Attachment I – Quality Assurance Project Plan (QAPP): A modified version of Table 1 of the Sampling and Analysis Plan (SAP) in Appendix D is attached to this document to summarize the MNA and Containment Cell groundwater monitoring network sampling requirements. The primary modifications are the inclusion of MW-4 and MW-6 to the MNA network per USEPA request and the substitution of well MW-2A to replace MW-2 once the CCB is built; and CC-6A to replace CC-6 once the CCB is built. This affects sections 2.1.6 and 2.1.7. We do not feel that generation of an amended SAP is necessary at this time.

We hope that the information presented in this document provides sufficient information to proceed with the generation and approval of the Explanation of Significant Differences in an expeditious manner such that 2015 CMI work can begin in earnest in August and that soil remediation can be completed by the end of 2015.

If you have any question please call Matthew Love at 610-921-4054 or Jan Dobinsky at 610-840-9136.

Sincerely,

ADVANCED GEOSERVICES CORP.

Jan S. Dobinsky
~~Senior Project Professional~~

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Enclosures

cc: Matthew Love, RMC
Tammy Ohl, USEPA
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Stacey Anagnostopoulos, TTNUS
Scott Ward, AGC
Joe Naselli, Op-Tech

AMMENDED CMD TABLE

TABLE 1
SAMPLING PARAMETERS AND REPORTING LIMITS
RMC Beechgrove, Indiana
Updated for Containment Celll Expansion (CCB) May, 2015

LOCATION	MATRIX	METHOD	PARAMETER	RL	DQO	UNITS
HWMU	Soil/ Sediment	SW-846 6020A[1]	Antimony	0.2	37	mg/kg
		SW-846 6010B[1]	Arsenic	1	20	mg/kg
			Cadmium	0.5	77	mg/kg
			Lead	0.3	970	mg/kg
			Selenium	0.5	53	mg/kg
outside HWMU, but still onsite		SW-846 6010B[1]	Lead	0.3	920	mg/kg
Offsite		SW-846 6010B[1]	Lead	0.3	400	mg/kg
Monitoring Well Installation (CC-1, 2, 3, 4, 5, 6; MW-2A and CC-6A)		SW-846 9045	pH	NA	NA	S.U.
		US EPA 2480D	eH	20	NA	millivolts
		SW-846 6020A	Antimony	0.2	37	mg/kg
		SW-846 6010B	Aluminum	20	NA	mg/kg
			Arsenic	1	20	mg/kg
			Barium	20	NA	mg/kg
			Beryllium	0.5	NA	mg/kg
			Cadmium	0.5	77	mg/kg
			Calcium	500	NA	mg/kg
			Chromium	1	NA	mg/kg
			Cobalt	5	NA	mg/kg
			Copper	2.5	NA	mg/kg
			Iron	10	NA	mg/kg
			Lead	0.3	970	mg/kg
			Magnesium	500	NA	mg/kg
			Manganese	1.5	NA	mg/kg
			Nickel	4	NA	mg/kg
			Potassium	500	NA	mg/kg
			Selenium	0.5	53	mg/kg
			Silver	1	NA	mg/kg
			Sodium	500	NA	mg/kg
			Thallium	1	NA	mg/kg
			Vanadium	5	NA	mg/kg
			Zinc	5	NA	mg/kg
		SW-846 7471	Mercury	0.1	NA	mg/kg
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	0.4	NA	mg/kg
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	0.5	NA	mg/kg
		Walkley Black	Total Organic Carbon	1000	NA	mg/kg
		SW-846 9056	Sulfate	10	NA	mg/kg
		ASTM D422-63	Gradation (Sieve and Hydrometer)	NA	NA	NA

TABLE 1
SAMPLING PARAMETERS AND REPORTING LIMITS
RMC Beechgrove, Indiana
Updated for Containment Celll Expansion (CCB) May, 2015

LOCATION	MATRIX	METHOD	PARAMETER	RL	DQO	UNITS
Containment Cell Monitoring (CC-1, 2, 3, 4, 5, 6/6A)	Aqueous	SW-846 6010B	Total and Dissolved Lead	1	15	µg/L
			Total and Dissolved Arsenic	1	10	µg/L
		SW-846 6020A	Total and Dissolved Antimony	2	6	µg/L
		SW-846 9040	pH	NA	NA	S.U.
		SW-846 9060	Total Organic Carbon	1	NA	mg/L
MNA (MW-1, 2/2A, 3, 4, 6, 8, 9, 12)	Aqueous	SW-846 6010B	Total and Dissolved Lead	1	15	µg/L
			Total Iron	50	NA	µg/L
			Total and Dissolved Arsenic	1	10	µg/L
		SW-846 9034	Sulfide	3	NA	mg/L
		SM 4500 SO3 B	Sulfite	5	NA	mg/L
		US EPA 300.0	Nitrate	0.1	NA	mg/L
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	2	10	µg/L
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	50	NA	µg/L
		Applied Speciated propriatary method	Manganese speciation (MnII/MnVII)	NA	NA	µg/L
Equipment Blanks	Aqueous	SW-846 6020A[1]	Total and Dissolved Antimony	2	NA	µg/L
		SW-846 6010B[1]	Total and Dissolved Arsenic	1	NA	µg/L
			Total Cadmium	1	NA	µg/L
			Total Iron	50	NA	µg/L
			Total and Dissolved Lead	1	NA	µg/L
			Total Selenium	5	NA	µg/L
		SW-846 9040	pH	NA	NA	S.U.
		SW-846 9060	Total Organic Carbon	1	NA	µg/L
		SW-846-9034	Sulfide	3	NA	µg/L
		SM 4500 SO3 B	Sulfite	5	NA	µg/L
		US EPA 300.0	Nitrate	0.1	NA	µg/L
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	2	NA	µg/L
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	50	NA	µg/L
		Applied Speciated propriatary method	Manganese speciation (MnII/MnVII)	NA	NA	µg/L

Notes:
Antimony will be analyzed by SW-846 6020A
µg/L: micrograms per liter RL: Reporting Limit
mg/L: milligrams per liter DQO: Data Quality Objective
mg/kg: milligrams per kilogram N/A: not applicable

[1]USEPA "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", Feb. 2007, SW-846, 6th Revision.

Field Parameters recorded for Containment Cell and MNA sampling: pH, Conductivity, Turbidity, ORP/eH, Temperature, Dissolved Oxygen.

Sulfate, Sulfite, Nitrate, and speciation analysis listed for MNA sampling are only performed for the first two quarterly events (March 2015 and June 2015)

MW-4 and MW-6 added to MNA network per USEPA request for four (4) quarters (March-June-September-November 2015); once four quarters of monitoring are completed they may be removed from the MNA network based on approval by USEPA.

AMMENDED ATTACHMENT C CALCULATIONS

EXCAVATION AND CCB CAPACITY ESTIMATION

CMD ATTACHMENT C – Ammended Excavation and CCB Quantity Calculations.

RMC- Beech Grove: 2015 Excavation Area Descriptions

Assumptions:

Review of CMD excavation areas. Incorporation of as-built excavation depths observed in completed excavations and test-pit observations to estimate remaining excavation quantity. HWMU lateral limits have been reached. Limited excavation on north side of HWMU, north east side of HWMU, beyond lateral limits may be needed to remove debris. Additional excavation internal to HWMU may be driven by sidewall sampling. Non-HWMU excavations do not require sidewall sampling. Lateral extents are assumed to be relatively fixed.

AA1

Design depth is 0.5 ft.
Historical sample results at 0.5 ft indicate potential to exceed PRG at that depth.
Evaluate deeper interval data. Consider additional excavation likely (1-ft final depth)

AA2

Design depth is 1 ft.
Historical sample results at 12" indicated exceedance of PRG.
Consider additional excavation likely (1.5-ft final depth)

AA3

Design depth is 1.5 ft
Historical sample results indicate exceedance of PRG at 12".
Design depth appears to consider excavation below 12" sample already.

AA4

Design depth is 2 ft.
Historical sample results indicate exceedance of PRG at 24"
Consider additional excavation likely (2.5-ft final depth)

AA5

Design depth is 1.5 ft
Historical 12" sample results exceed PRG, but 18" results are below.
Additional excavation unlikely.

AA6

Design depth is 1 ft.
Historical 12" sample results exceed PRG, but 18" results are below.
Consider additional excavation to 1.5 ft.

DW1

Design depth is 2 ft

Historical sample results indicate exceedance of PRG at 12".
Design depth appears to consider excavation below 12" sample already.
Completed excavation in other portions of the area was 0.9 to 2.5 ft. Assume excavation depth accurate.

DW2
Design depth is 2 ft.
Historical sample results indicate exceedance of PRG at 12".
Evaluate deeper interval data. Design depth appears to consider excavation below 12" sample already

ND1
Design depth is 1ft.
Historical sample results indicate exceedance of PRG at 12".
XRF results show high levels of lead after 1 ft. excavation.
Excavation completed to 0.9 – 2 ft depth in other portions. Consider additional excavation likely (1-ft additional depth)

ND2
Design depth is 1 ft.
Historical sample results indicate passing results of PRG at 10".
XRF results show high levels of lead after 1 ft. excavation.
Evaluate deeper interval data. Consider additional excavation likely (2-ft depth?)

FL1
Design depth is 0.5 ft.
Historical sample results indicate exceedance of PRG at 10".
Evaluate deeper interval data. Consider additional excavation likely based on FL2 depth (1.5-ft final depth)

FL2
Design depth is 1 ft.
Historical sample results indicate passing results of PRG at 30".
Treatability and test pit sampling shows exceedance of PRG at approximately 24".
Avg excavation depth in completed areas = 2.7 ft.
Evaluate deeper interval data. Consider additional excavation likely (3-ft final depth)

FL3
Design depth is 3 ft.
Historical sample results indicate exceedance of PRG at 30".
Test pit sampling shows exceedance of PRG at approximately 30".
Design depth appears to consider excavation below 30" sample already.

FL4A
Design depth is 1 ft.

Historical sample results indicate exceedance of PRG at 30".
Consider additional excavation likely (2.5 ft final depth)

FL5
Design depth is 3 ft.
Historical sample results indicate exceedance of PRG at 30".
Test pit sampling shows exceedance of PRG at approximately 30".
Design depth appears to consider excavation below 30" sample already.

WP1A
Design depth is 2.5 ft.
Historical sample results indicate passing results of PRG at 36".
XRF sidewall results show high levels of lead after 2.5 ft. excavation.
Treatability and test pit sampling show exceedances of PRG at approximately 2 ft.
Excavation depth completed in other portions of WP1A ranges from 2.8 – 6-ft bepth. Assume additional 2-ft below design depth may be needed.
Continue to chase debris and evaluate internal sidewalls using XRF.

WP2A
Design depth is 7.3 ft.
Historical sample results indicate passing results of PRG at 84".
Evaluate deeper interval data. Design depth appears to consider excavation below 84" sample already.
Completed excavation is other portions of WP2A ranges 6.4 to 7.5 ft depth.
Continue to chase debris and evaluate internal sidewalls using XRF.

WP2B
Design depth is 2.5 ft.
Historical sample results indicate passing results of PRG at 10" and 15".
XRF sidewall results show high levels of lead after 2.5 ft. excavation.
Completed excavation in other portions of WB2B ranges 3.5 to 7.5 ft depth. Assume another 3-ft of excavation below design depth may be needed.
Continue to chase debris and evaluate internal sidewalls using XRF.

MSB1AX
Projected design depth is 2.5 ft. based on test pit evaluations.
Historical sample results indicate passing results of PRG at 15".
XRF sidewall results show high levels of lead after 2.5 ft. excavation.
Treatability and test pit sampling show exceedances of PRG at approximately 2 ft.
Completed excavation depth in other portions of MSB1AX ranges 1.6 to 5.7 ft depth. Assume another 3-ft of excavation below design depth may be needed.
Continue to chase debris and evaluate internal sidewalls using XRF.

CG1
Design depth is 0.5 ft.
Historical sample results indicate passing results of PRG at 6".
Treatability and test pit sampling show exceedance of PRG at approximately 6".
Additional excavation unlikely.

CG2
Design depth is 0.5 ft.
Historical sample results indicate passing results of PRG at 6".
Treatability and test pit sampling shows exceedance of PRG at approximately 6".
Additional excavation unlikely.

CSX
Design depth is 1 ft.
Treatability samples show exceedances of PRG at approximately 12".
Evaluate deeper interval data. Consider additional excavation likely (1.5-ft depth?)

AMT1
Design depth is 0.5 ft.
Historical sample results indicate passing results of PRG at 10".
Additional excavation unlikely.

ATM2
Design depth is 1 ft.
Historical 10" sample results indicate passing results of PRG, but 12" results exceed the PRG goals.
Evaluate deeper interval data. Consider additional excavation likely (1.5 ft depth?)

AMT3
Design depth is 0.5 ft.
Historical sample results indicate exceedances of PRG at 6".
Evaluate deeper interval data. Consider additional excavation likely (1 ft depth?)

HWMU Excavation Tracking (Based on CMD Volume, does not include over excavation quantities)

Location	CMD Volume (CF)	CMD Volume (CY)	Excavation Complete	2014 Excavation Volume (	Excavation Remaining (CY)
WP1A	20082	744	N	714	[redacted]
WP1B	2300	85	Y	894	0
WP1C	1805	67	Y	291	0
WP1D	1196	44	Y	125	0
WP1DX	0	0	Y	1777	0
WP2A	30708	1,137	N	1210	[redacted]
WP2B	13342	494	N	1463	[redacted]
WP2C	2773	103	Y	657	0
WP3A	1360	50	Y	131	0
WP3B	3317	123	Y	66	0
WP6A	17912	663	Y	1299	0
WP6B	455	17	Y	37	0
MSB1A/MSB1AX	13933	516	N	2114	[redacted]
MSB1B	1778	66	Y	116	0
MSB2A	12124	449	N	1568	[redacted]
MSB2B	9967	369	Y	547	0
Lagoon	9259	343	Y	774	0
total		5,271		13,783	1,900
Overexcavation (estimated)				8,512	1,200

Onsite Excavation Tracking (Based on CMD Volume, does not include over excavation quantities)

Location	CMD Volume (CF)	CMD Volume (CY)	Excavation Complete	2014 Excavation Volume (	Excavation Remaining (CY)
AA1	7957	295	N	0	[redacted]
AA2	3826	142	N	0	[redacted]
AA3	4515	167	N	0	[redacted]
AA4	4820	179	N	0	[redacted]
AA5	2267	84	N	0	[redacted]
AA6	14932	553	N	0	[redacted]
DW1	12796	474	N	218	[redacted]
DW2	10938	405	N	0	[redacted]
ND1	4673	173	N	195	[redacted]
ND2	4844	179	N	183	[redacted]
NW	21123	782	Y	977	0
FL1	4407	163	N	0	[redacted]
FL2	18444	683	N	257	[redacted]
FL3	31800	1,178	N	0	[redacted]
FL4A	11041	409	N	0	[redacted]
FL4B	4552	169	Y	391	0
FL4BX	0	0	Y	936	0
FL5	35409	1,311	N	0	[redacted]
OE1	6803	252	Y	203	0
total		7,162		3,360	5,768
Overexcavation (estimated)				1,380	500

Offsite Excavation Tracking (Based on CMD Volume, does not include over excavation quantities)

Location	CMD Volume (CF)	CMD Volume (CY)	Excavation Complete	2014 Excavation Volume (	Excavation Remaining (CY)
CSX	4787	177	N	0	[redacted]
CGE-1	3483	129	N	0	[redacted]
CGE-2	8501	315	N	0	[redacted]
CGE-3	3863	143	N	0	[redacted]
CGE-4	1762	65	N	0	[redacted]
CGE-5	900	33	N	0	[redacted]
CGE-6	27315	1,012	(By Others)	0	0
CGE-7	4125	153	(By Others)	0	0
CGE-8	3420	127	(By Others)	0	0
CG1	935	35	N	0	[redacted]
CG2	2703	100	N	0	[redacted]
AMT1	1371	51	N	0	[redacted]
AMT2	5874	218	N	0	[redacted]
AMT3	139	5	N	0	[redacted]
		2,385			1,094

Remaining CMD Excavation	7,561
Remaining Overexcavation	1,700
Remaining Concrete removal	425
	9,686

Remaining HWMU Excavations (sidewalls, debris removal, etc)

Location	Remaining Area	CMD Depth	Additional Depth	Volume (CF)	Volume (CY)	Non-Haz	Haz
WP1A	2471	2.5	2	11119.5	412	0	412
WP2A	1666	7.3	0	12161.8	450	0	450
WP2B	4553	2.5	3	25041.5	927	0	927
MSB1AX	3782	1	3	15128	560	0	560
Concrete Removal					425	425	
Subtotal					**2,775**	**425**	**2,350**

Remaining non-HWMU Excavations (Lead PRG 920 mg/kg; bottom samples only)

Location	Remaining Area	CMD Depth	Additional Depth	Volume (CF)	Volume (CY)	Non-Haz	Haz
DW1	3059	2	0	6118	227	0	227
DW2	5469	2	0	10938	405	0	405
ND1	4200	1	1	8400	311	0	311
ND2	4200	1	1	8400	311	0	311
FL1	8815	0.5	1	13222.5	490	0	490
FL2	15870	1	2	47610	1,763	0	1,763
FL3	10600	3	0	31800	1,178	0	1,178
FL4A	11041	1	1.5	27602.5	1,022	0	1,022
FL5	11803	3	0	35409	1,311	0	1,311
Subtotal					**7,019**	**0**	**7,019**

Remaining Offsite/ROW Excavations (400 mg/kg PRG)

Location	Remaining Area	CMD Depth	Additional Depth	Volume (CF)	Volume (CY)	Non-Haz	Haz
AA1	15914	0.5	0.5	15914	589	589	
AA2	3826	1	0.5	5739	213	213	
AA3	3010	1.5	0	4515	167	167	
AA4	2410	2	0.5	6025	223	223	
AA5	1511	1.5	0	2266.5	84	0	84
AA6	14932	1	0.5	22398	830	0	830
CSX	4787	1	1	9574	355	0	355
CG1	1871	0.5	0	935.5	35	35	
CG2	2703	1	0	2703	100	100	
AMT1	0	0.5	0	0	0	0	
AMT2	5400	1	0	5400	200	200	
AMT3	279	0.5	0	139.5	5	0	5
Subtotal	(includes otherpotential CG excavations)				**3,453**	**2,179**	**1,273**
					9,819		

Total Excavation	13,246	CY
Non-Haz DisposalT&D	2,604	CY
Haz Treatment, T&D	10,642	CY

CGE Volumes	652
CGE CMD Volumes	340
Total Potential CG	992

CONTAINMENT CELL WASTE CAPACITY					
MINIMUM WITH CCB EXTENSION					
ELEVATION	AREA (SF)	DIFF DEPTH (FT)	VOL (CF)	CUM. VOL (CF)	CUM. VOL (CY)
841.5	79,744				
		0.5	40,808	40,808	1,511
842	83,490				
		2	162,165	202,973	7,518
844	78,675				
		2	150,081	353,054	13,076
846	71,406				
		2	131,462	484,516	17,945
848	60,056				
		2	109,494	594,010	22,000
850	49,438				
		2	88,992	683,002	25,296
852	39,554				
		2	69,956	752,958	27,887
854	30,402				
		2	52,296	805,254	29,824
856	21,894				
		2	38,596	843,850	31,254
858	16,702				
		1	15,500	859,350	31,828
859	14,298				
		1	8,172	867,522	32,130
860	2,046				
		0.5	512	868,033	32,149
860.5	0				

Minumum Grading Capacity	32,149
Previously Placed Waste	21,490
CCB Minimum Volume (Approx.)	**10,659**

CONTAINMENT CELL WASTE CAPACITY					
MAXIMUM WITH CCB EXTENSION					
ELEVATIO N	AREA (SF)	DIFF DEPTH (FT)	VOL (CF)	CUM. VOL (CF)	CUM. VOL (CY)
841.5	79,744				
		0.5	22,236	22,236	824
842	9,200				
		2	92,691	114,927	4,257
844	83,491				
		2	159,559	274,486	10,166
846	76,068				
		2	145,002	419,488	15,537
848	68,934				
		2	131,023	550,511	20,389
850	62,089				
		2	117,620	668,131	24,746
852	55,531				
		2	104,792	772,923	28,627
854	49,261				
		2	92,541	865,464	32,054
856	43,280				
		2	80,866	946,330	35,049
858	37,586				
		1	36,217	982,546	36,391
859	34,847				
		1	22,805	1,005,351	37,235
860	10,762				
		0.5	2,691	1,008,041	**37,335**
860.5	0				

Minumum Grading Capacity	37,335
Previously Placed Waste	21,490
CCB Maximum Volume (Approx.)	**15,845**

AMMENDED STORMWATER WORKSHEETS AND DRAWINGS

WORKSHEETS

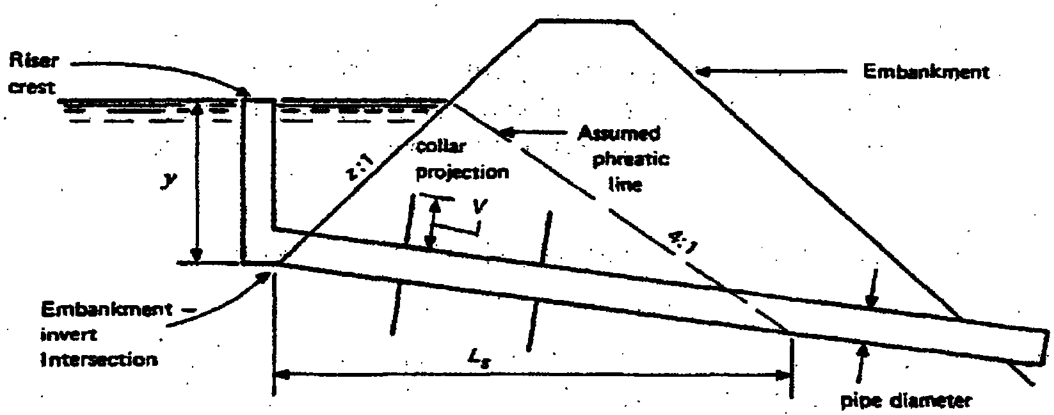
ADVANCED GeoServices Engineering for the Environment. Planning for People.™ 1055 Andrew Drive, Suite A - West Chester, PA 19380 (610) 840-9100 - Fax (610) 840-9199	PROJECT: RMC BEECH GROVE	
	SUBJECT: EROSION CONTROL DESIGN	
	SHEET: 1 OF 1	DATE: 11/20/2012
	BY: DJS	REVISED 6/15/2015
	CHK'D: PGS	20031046

ANTI-SEEP COLLAR DESIGN

Design based upon PA DEP Erosion and Sediment Pollution Control Program Manual.

BASIN NAME	RISER CREST ELEVATION	INSIDE TOE OF SLOPE ELEVATION	SLOPE, Z	INSIDE DEPTH, Y	PIPE SLOPE, FT/FT	PIPE DIA., FT	SATURATED LENGTH	NUMBER OF COLLARS	COLLAR PROJECTION, FEET
Basin 1	841.95	840.20	3	1.75	0.004	1.50	12.4	1	2.0
Basin 2	840.71	838.70	3	2.01	0.004	1.25	14.3	1	2.0
Wetland	841.50	840.50	3	1.00	0.004	0.67	7.1	1	2.0

Anti-seep Collar Design



ADVANCED GeoServices Engineering for the Environment. Planning for People.™ 1055 Andrew Drive, Suite A - West Chester, PA 19380 (610) 840-9100 - Fax (610) 840-9199	PROJECT: Beech Grove			
	SUBJECT: RipRap Apron			
	SHEET: 1 OF 2		DATE:	
	BY:	DJS	REVISED	6/15/2015
	CHK'D:	PGS		20031046

Basin 1 Outlet RipRap Apron

10-Year Peak Rate Qd= 4.27 CFS

$$Qf = \frac{0.464}{n} D^{8/3} S^{1/2}$$

$$V = \frac{Q}{A} \qquad d/D = \frac{Qd}{Qf}$$

Manning's n=	n=	0.012	
Diameter=	D=	1.50	ft
Slope=	S=	0.004	ft/ft
Peak Rate=	Qf=	7.21	cfs
	d/D=	0.59	
Area=	A=	1.767	sf
	Vf=	4.08	fps
Velocity Ratio (Fig 9.1)=		1.04	
	Vd=	4.243	fps

Basin 2 Outlet RipRap Apron

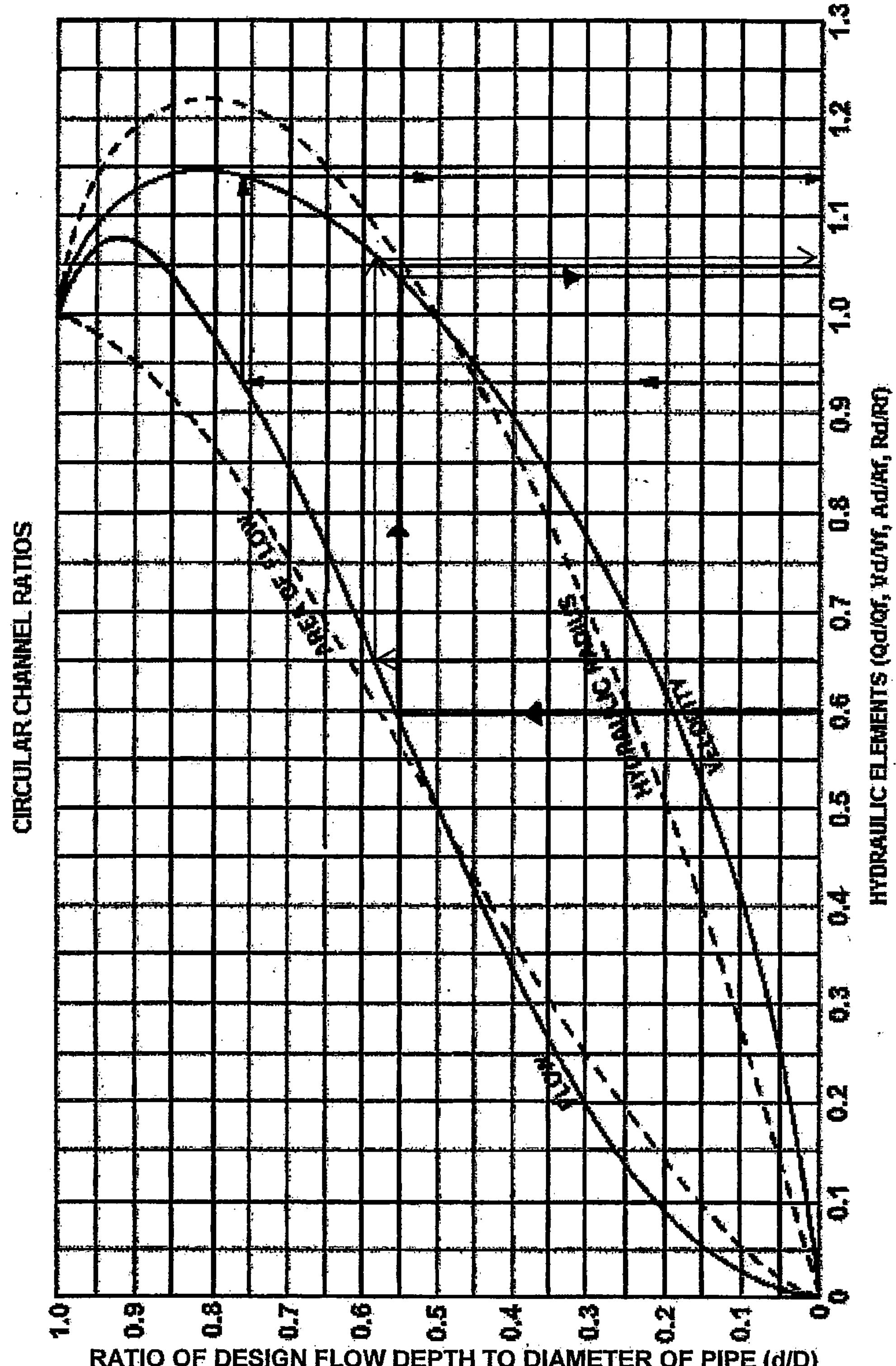
10-Year Peak Rate Qd= 4.37 CFS
10-year Peak Rate Qd= 1.46 CFS (Each of 3 Pipes)

$$Qf = \frac{0.464}{n} D^{8/3} S^{1/2}$$

$$V = \frac{Q}{A} \qquad d/D = \frac{Qd}{Qf}$$

Manning's n=	n=	0.012	
Diameter=	D=	1.25	ft
Slope=	S=	0.004	ft/ft
Peak Rate=	Qf=	4.65	cfs
	d/D=	0.31	
Area=	A=	1.227	sf
	Vf=	3.789	fps
Velocity Ratio (Fig 9.1)=		1.02	
	Vd=	3.865	fps

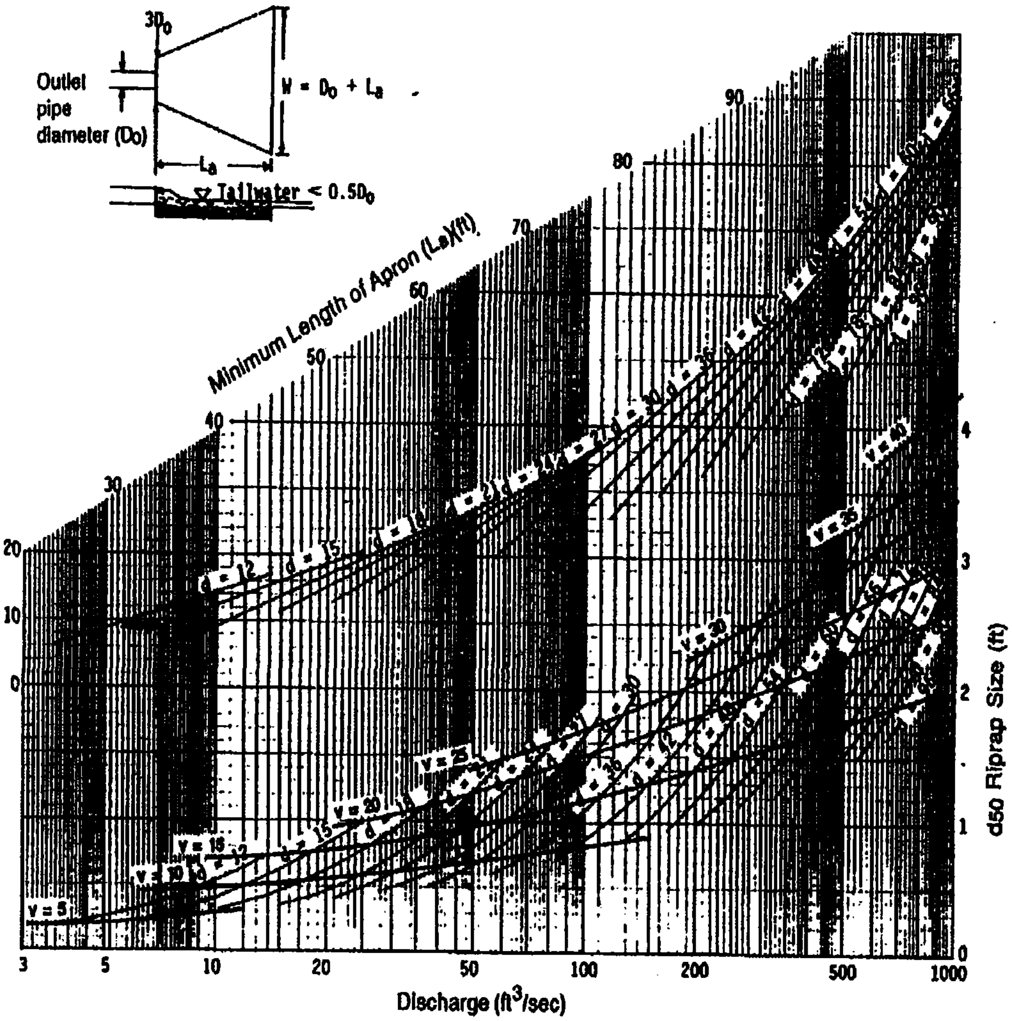
FIGURE 9.1
Velocity Adjustment Nomograph for Less Than Full Pipe Flow



Adapted from *Design and Construction of Sanitary and Storm Sewers*, p. 87, ASCE, 1969

BASIN 1

Do not use this nomograph to determine "equivalent pipe sizes" for discharges (Q_d) that do not intersect curves corresponding to proposed pipe sizes on Figures 9.3 and 9.4.

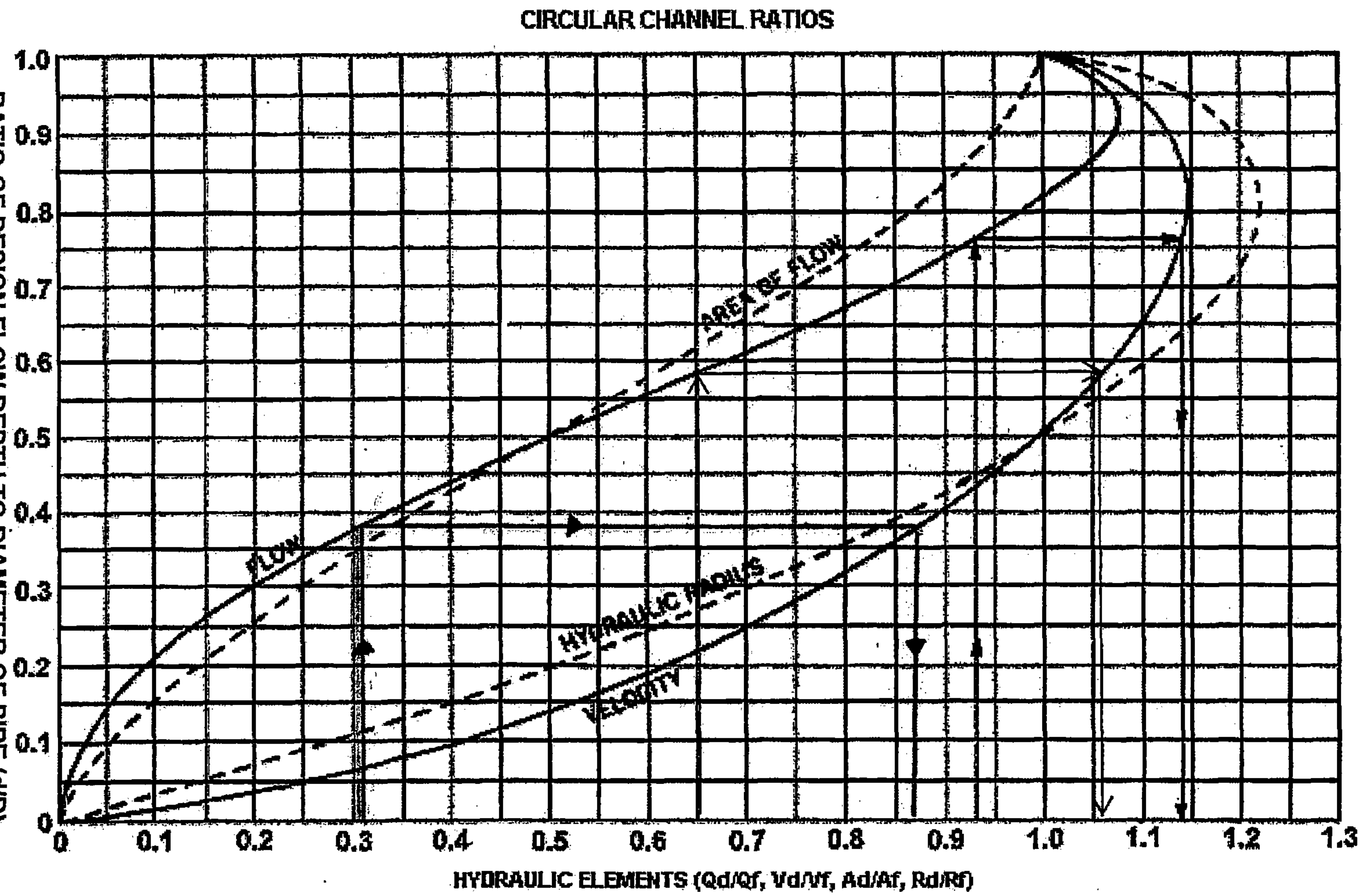


Curves may not be extrapolated.

BASIN 1

FIGURE 304-03: Outlet Protection with Minimum Tailwater Condition
SOURCE: North Carolina Erosion & Sediment Control Planning & Design Manual, 09/01/88

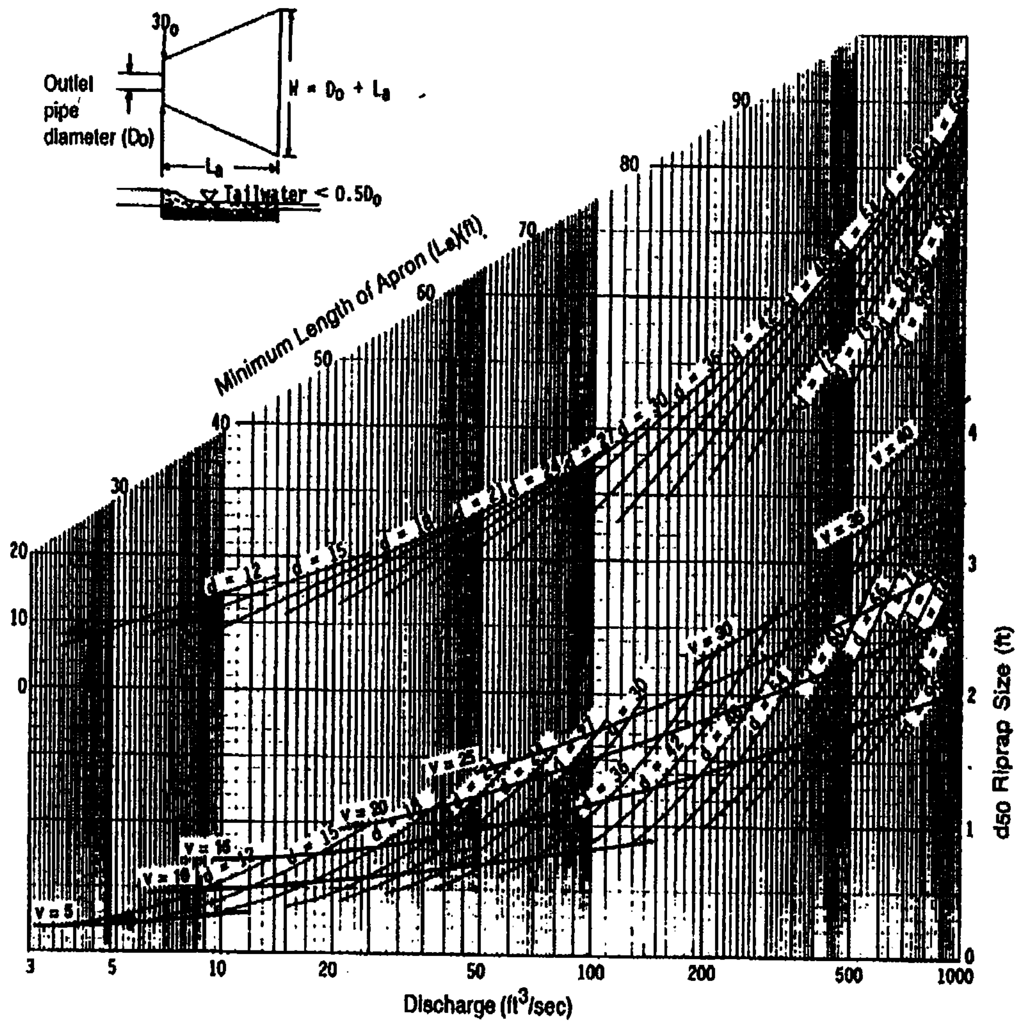
FIGURE 9.1
Velocity Adjustment Nomograph for Less Than Full Pipe Flow



Adapted from, *Design and Construction of Sanitary and Storm Sewers*, p. 87, ASCE, 1969

Do not use this nomograph to determine "equivalent pipe sizes" for discharges (Q_d) that do not intersect curves corresponding to proposed pipe sizes on Figures 9.3 and 9.4.

BASIN - 2



Curves may not be extrapolated.

BASIN 2

FIGURE 304-03: Outlet Protection with Minimum Tailwater Condition

SOURCE: North Carolina Erosion & Sediment Control Planning & Design Manual, 09/01/88

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(610) 840-9100 - Fax (610) 840-9199

PROJECT:	BEECH GROVE				
SUBJECT:	EMERGENCY SPILLWAY DESIGN				
SHEET:	1	OF	1	DATE:	11/20/2012
BY:			DJS	REVISED	6/12/2015
CHK'D:			PGS		20031046

EMERGENCY SPILLWAY DESIGN

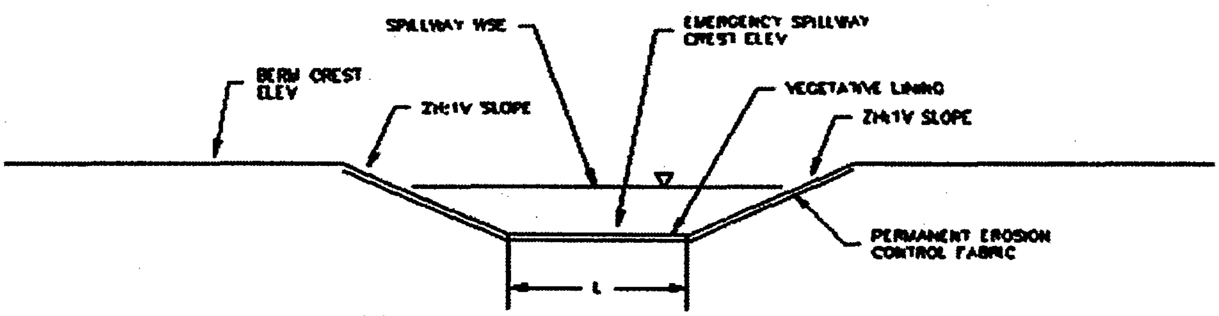
Design is based upon broad-crested wier formula for a trapezoidal shape: Q = c x A x (h^1/2)

Broad-Crested Wier Coefficient: 2.80

BASIN NAME	BASIN INFLOW (cfs)	SPILLWAY CREST ELEV.	SLOPE, Z	WATER ELEVATION, WSE	SPILLWAY LENGTH	SPILLWAY CAPACITY (cfs)	SPILLWAY STATUS	BERM CREST ELEV.
Basin 1	18.7	842.50	3.0	842.93	24.00	20.0	GOOD	844.00
Basin 2	18.6	841.10	3.0	841.38	45.00	19.0	GOOD	842.50
Wetland	10.7	842.50	3.0	842.75	30.00	10.8	GOOD	844.00
Overflow	9.1	839.50	3.0	839.76	40.00	15.1	GOOD	840.76

BASIN NAME	BASIN FLOW AREA (SF)	VELOCITY (FPS)	PROPOSED LINER
Basin 1	10.9	1.84	R-3 RIPRAP*
Basin 2	12.8	1.48	R-3 RIPRAP*
Wetland	7.7	1.40	R-3 RIPRAP*
Overflow	10.6	1.43	R-3 RIPRAP*

*D50=3"



NOTE:

SPILLWAY WATER SURFACE ELEVATION IS BASED UPON 100-YEAR POSTDEVELOPMENT RUNOFF FLOWING OVER EMERGENCY SPILLWAY ONLY.

EMERGENCY SPILLWAY SECTION
NOT TO SCALE

ADVANCED GeoServices Engineering for the Environment. Planning for People.™ 1055 Andrew Drive, Suite A - West Chester, PA 19380 (610) 840-9100 - Fax (610) 840-9199	PROJECT: RMC Beech Grove		
	SUBJECT: Water Quality Volume and Pocket Wetland Design		
	SHEET: 1 OF 1	DATE:	11/19/2012
	BY: DJS	REVISED	6/12/2015
	CHK'D: PGS		20031046

$$WQv = \frac{P*Rv*A}{12}$$

P= Rainfall Amount (Inches)
Rv= 0.05+0.009*Impervious Cover
I= % Impervious Cover

Area to Basin 1			**Area to Basin 2**		
I=	18.8 %		I=	2.36 %	
Rv=	0.22		Rv=	0.07	
A=	4.89 Acres		A=	0.59 Acres	
WQv=	0.09 Acre-Ft		WQv=	0 Acre-Ft	
WQv=	**3,889**	**cuft**	**WQv=**	**152**	**cuft**

Total Requrired WQv= 4,042 cuft
WQv Provided= 5,476 cuft at elevation 840.75

Water Balance

S=Qi+R+Inf-Qo-ET

S= net change in storage
Qi= stormwater runoff inflow
R= contribution from rainfall
Inf= net infiltration
Qo= surface outflow
ET= evapotranspiration

(from Report of Investigation 57: Monthly Lake Evaporation in Inches at Indianapolis for July from 1911 to 1962 is 5.46 inches)

S=footprint of basin x evaporation rate
S= (2,768 sf)x(5.46 in/12 in)
S= 1,259 cuft **Proposed Permanent Storage= 3,088 cuft**

Minimum Wetland Surface Area

A=1.5% of Total Drainage Area*
A= 0.07 acres
A= 3,194 sf **Provided= 4,407 sf**

Minimum Forebay Sizing

V=10% of Wetland Volume
V= 548 cuft **Volume Provided= 1,014 cuft**

*Per 702.02.5 of City of Indianapolis Stormwater Specifications Manual for Shallow Marsh Design

F:\Projects\2003\20031046-RMC Beech Grove Corr Measures Study\Work Documents\SWM\water quality volume 5-29-15.xlsx

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PROJECT:	BEECH GROVE		
SUBJECT:	Time of Concentration (Tc) Calculations		
SHEET: 3 OF 5		DATE:	5/4/2011
BY:	MRD	REVISED	5/29/2015
CHK'D:	PGS		20031046

Time of Concentration calculations with the application of the SCS TR-55 methodology.

Watershed or Subarea Designation: Basin 1

SHEET FLOW

Segment ID	AB	BC		
Surface Description (Table 203-1)	PAVED	GRAVEL		
Manning's Coefficient (Table 203-1)	0.011	0.011		
Flow Length, ft (total <= 100)	87	13		
Two Year Rainfall (in)	2.6	2.6		
Land Slope (ft/ft)	0.003	0.003		
Computed Tt, hrs.	0.042	0.009		0.051

SHALLOW CONCENTRATED FLOW

Segment ID	CD	DE	DF	
Surface Description (paved/unpaved)	GRAVEL	GRAVEL	GRAVEL	
Flow Length, ft	59.8	73.2	57.5	
Watercourse slope (ft/ft)	0.003	0.007	0.017	
Average Velocity (Figure 203-02)	1.2	1.9	2.4	
Computed Tt, hrs.	0.014	0.011	0.007	0.032

CHANNEL FLOW

Segment ID				
Cross sectional Area (sf)				
Wetted Perimeter, (ft)				
Hydraulic Radius, (ft)				
Channel Slope (ft/ft)				
Manning's Roughness Coefficient, n				
Computed Velocity, (fps)				
Flow Length, (ft)				
Computed Tt, hrs.				0.00

Watershed or Subarea Tc		
	0.083	hrs.
	4.95	min.

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Engineering for the Environment. Planning for People.™
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(610) 840-9100 - Fax (610) 840-9199

PROJECT:	BEECH GROVE				
SUBJECT:	Time of Concentration (Tc) Calculations				
SHEET:	4	OF	5	DATE:	5/4/2011
BY:			MRD	REVISED	5/29/2015
CHK'D:			PGS		20031046

Time of Concentration calculations with the application of the SCS TR-55 methodology.

Watershed or Subarea Designation: Basin 2

SHEET FLOW

Segment ID	AB	BC	CD	
Surface Description (Table 203-01)	PAVED	GRAVEL	GRAVEL	
Manning's Coefficient (Table 203-01)	0.011	0.011	0.011	
Flow Length, ft (total <= 100)	32	29	39	
Two Year Rainfall (in)	2.6	2.6	2.6	
Land Slope (ft/ft)	0.031	0.035	0.009	
Computed Tt, hrs.	0.008	0.007	0.015	0.029

SHALLOW CONCENTRATED FLOW

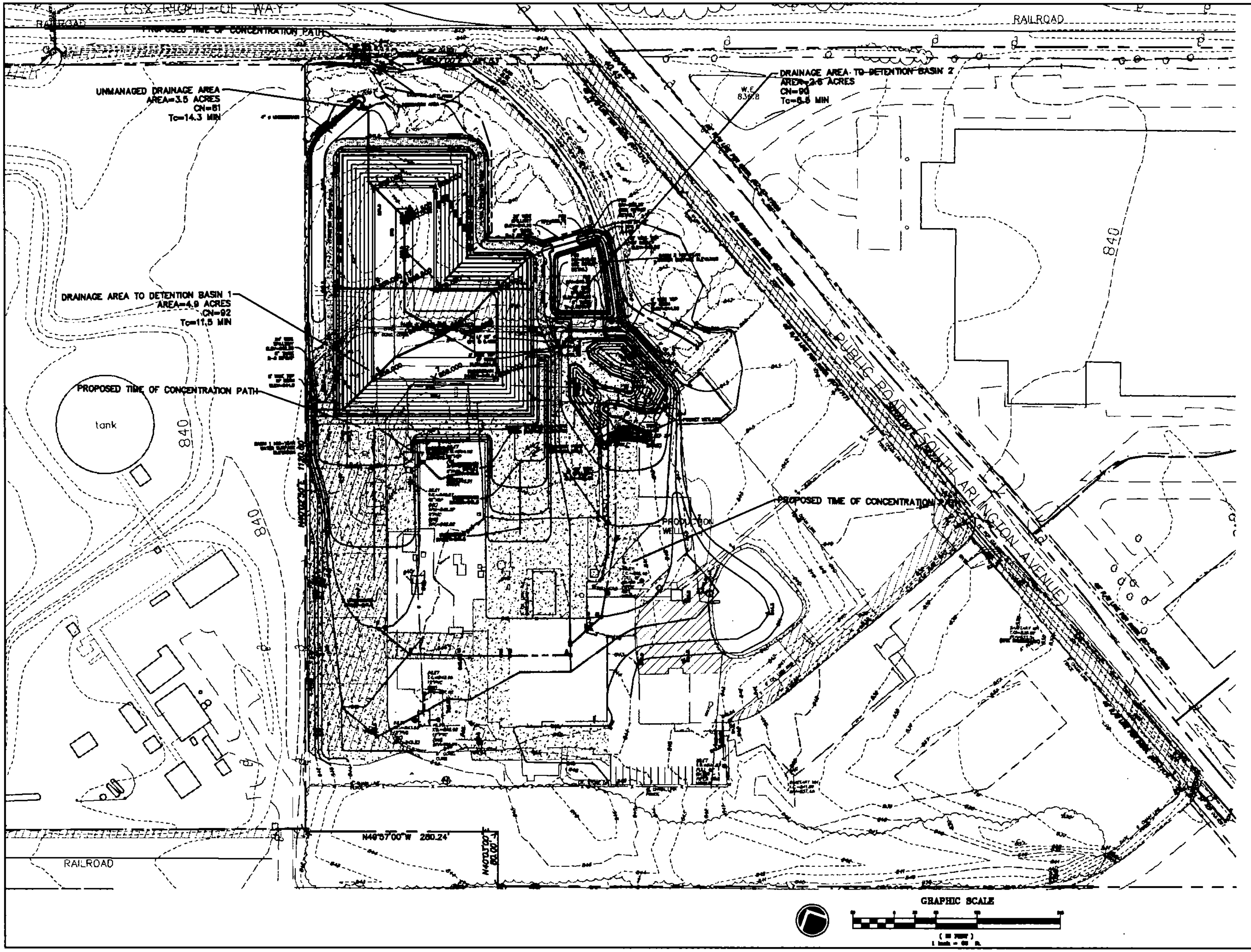
Segment ID	DE	EF		
Surface Description (paved/unpaved)	GRAVEL	GRAVEL		
Flow Length, ft	74	144		
Watercourse slope (ft/ft)	0.009	0.014		
Average Velocity (Figure 203-02)	2.0	2.4		
Computed Tt, hrs.	0.011	0.017		0.027

CHANNEL FLOW

Segment ID				
Cross sectional Area (sf)				
Wetted Perimeter, (ft)				
Hydraulic Radius, (ft)				
Channel Slope (ft/ft)				
Manning's Roughness Coefficient, n				
Computed Velocity, (fps)				
Flow Length, (ft)				
Computed Tt, hrs.				

Watershed or Subarea Tc	0.056	hrs.
	3.36	min.

DRAWINGS



LEGEND

ADVANCED GeoServices

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REFINED METALS CORPORATION
BEECH GROVE, INDIANA

STORWATER MANAGEMENT DESIGN &
STORMWATER POLLUTION PREVENTION PLAN

PROPOSED CONDITIONS DRAINAGE AREA PLAN

DA-02

1"=60'

2003-1046

2 OF 8

AMMENDED HYDROCAD 1-HR STORM DISCHARGE REPORT PROPOSED CONDITIONS

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=3.56 cfs 0.327 af
Primary=3.56 cfs 0.327 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=1.99 cfs 1.057 af
Primary=1.99 cfs 1.057 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=1.60 cfs 0.095 af
Primary=1.60 cfs 0.095 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=2.98 cfs 0.480 af
Primary=2.98 cfs 0.480 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=1.83 cfs 1.222 af
Primary=1.83 cfs 1.222 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=2.46 cfs 0.577 af
Primary=2.46 cfs 0.577 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=2.97 cfs 0.197 af
Primary=2.97 cfs 0.197 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=2.05 cfs 0.770 af
Primary=2.05 cfs 0.770 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=7.38 cfs 0.757 af
Primary=7.38 cfs 0.757 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=3.69 cfs 1.944 af
Primary=3.69 cfs 1.944 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=4.53 cfs 0.270 af
Primary=4.53 cfs 0.270 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=6.27 cfs 1.058 af
Primary=6.27 cfs 1.058 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=2.99 cfs 2.312 af
Primary=2.99 cfs 2.312 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=5.56 cfs 1.229 af
Primary=5.56 cfs 1.229 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=6.92 cfs 0.498 af
Primary=6.92 cfs 0.498 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=4.73 cfs 1.581 af
Primary=4.73 cfs 1.581 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=9.11 cfs 0.995 af
Primary=9.11 cfs 0.995 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=4.55 cfs 2.411 af
Primary=4.55 cfs 2.411 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=6.36 cfs 0.377 af
Primary=6.36 cfs 0.377 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=7.73 cfs 1.346 af
Primary=7.73 cfs 1.346 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=3.65 cfs 2.881 af
Primary=3.65 cfs 2.881 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=7.10 cfs 1.560 af
Primary=7.10 cfs 1.560 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=9.07 cfs 0.673 af
Primary=9.07 cfs 0.673 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=5.89 cfs 1.945 af
Primary=5.89 cfs 1.945 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=11.70 cfs 1.404 af
Primary=11.70 cfs 1.404 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=5.93 cfs 3.174 af
Primary=5.93 cfs 3.174 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=9.29 cfs 0.547 af
Primary=9.29 cfs 0.547 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=10.37 cfs 1.869 af
Primary=10.37 cfs 1.869 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED

Inflow=4.73 cfs 3.849 af
Primary=4.73 cfs 3.849 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=9.70 cfs 2.154 af
Primary=9.70 cfs 2.154 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=12.28 cfs 0.954 af
Primary=12.28 cfs 0.954 af

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Link 8L: TOTAL POSTDEVELOPED Inflow=8.00 cfs 2.648 af
Primary=8.00 cfs 2.648 af

AMMENDED HYDROCAD STORM SUMMARY REPORTS
PROPOSED CONDITIONS

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment2S: AREA TO BASIN 1	Runoff Area=3.920 ac 18.80% Impervious Runoff Depth=0.54" Tc=5.0 min CN=91 Runoff=3.57 cfs 0.177 af
Subcatchment3S: AREA TO BASIN 2	Runoff Area=1.738 ac 3.16% Impervious Runoff Depth=0.41" Tc=5.0 min CN=88 Runoff=1.09 cfs 0.059 af
Subcatchment4S: UNMANAGED AREA	Runoff Area=4.005 ac 0.00% Impervious Runoff Depth=0.24" Tc=14.3 min CN=83 Runoff=1.42 cfs 0.082 af
Subcatchment9S: AREA TO BASIN 2	Runoff Area=0.589 ac 0.00% Impervious Runoff Depth=0.27" Tc=5.0 min CN=84 Runoff=0.23 cfs 0.013 af
Pond 5P: BASIN 1	Peak Elev=841.18' Storage=806 cf Inflow=3.57 cfs 0.177 af 18.0" x 75.1' Culvert Outflow=2.44 cfs 0.178 af
Pond 6P: POCKET WETLAND	Peak Elev=840.80' Storage=2,297 cf Inflow=1.09 cfs 0.059 af 8.0" x 45.1' Culvert Outflow=0.20 cfs 0.055 af
Pond 7P: BASIN 2	Peak Elev=839.57' Storage=4,144 cf Inflow=2.77 cfs 0.246 af 15.0" x 40.0' Culvert Outflow=2.22 cfs 0.246 af
Link 8L: TOTAL POSTDEVELOPED	Inflow=3.56 cfs 0.327 af Primary=3.56 cfs 0.327 af

Total Runoff Area = 10.252 ac Runoff Volume = 0.331 af Average Runoff Depth = 0.39"
92.27% Pervious = 9.460 ac 7.73% Impervious = 0.792 ac

Summary for Subcatchment 2S: AREA TO BASIN 1

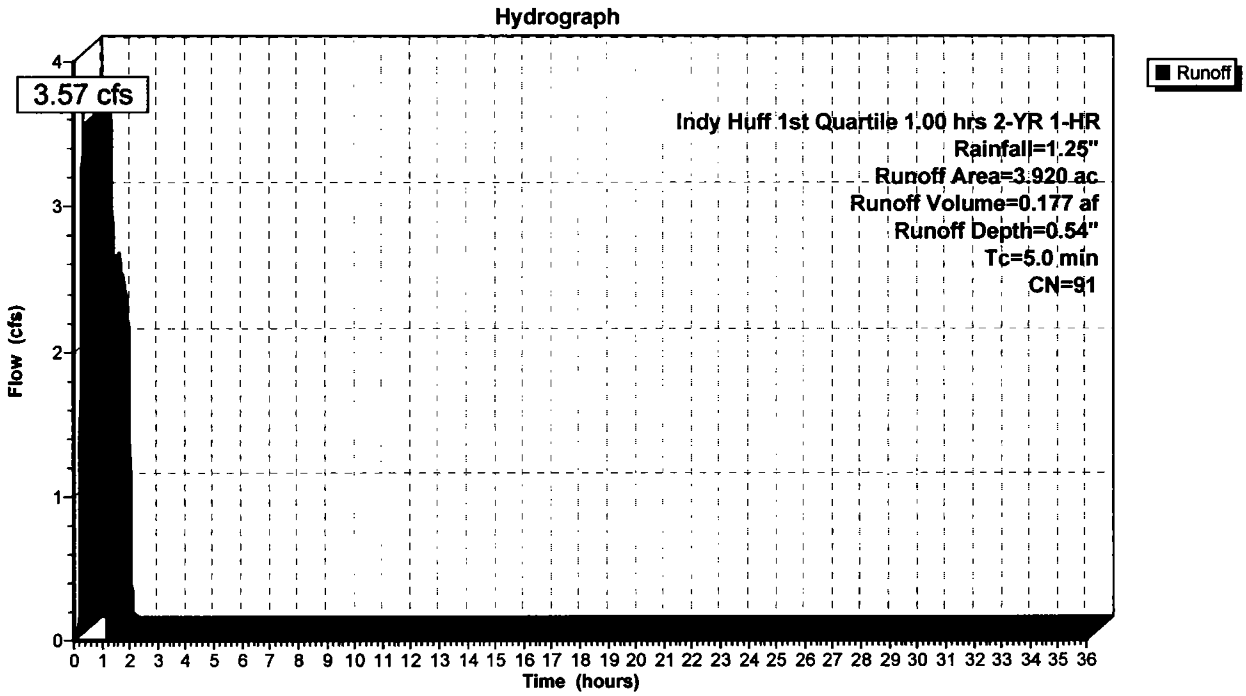
Runoff = 3.57 cfs @ 0.35 hrs, Volume= 0.177 af, Depth= 0.54"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 2-YR 1-HR Rainfall=1.25"

	Area (ac)	CN	Description
	0.737	98	Paved parking & roofs
	2.629	91	Gravel roads, HSG D
*	0.554	84	50-75% Grass Cover, Fair, HSG D
	3.920	91	Weighted Average
	3.183		Pervious Area
	0.737		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: AREA TO BASIN 1



Summary for Subcatchment 3S: AREA TO BASIN 2

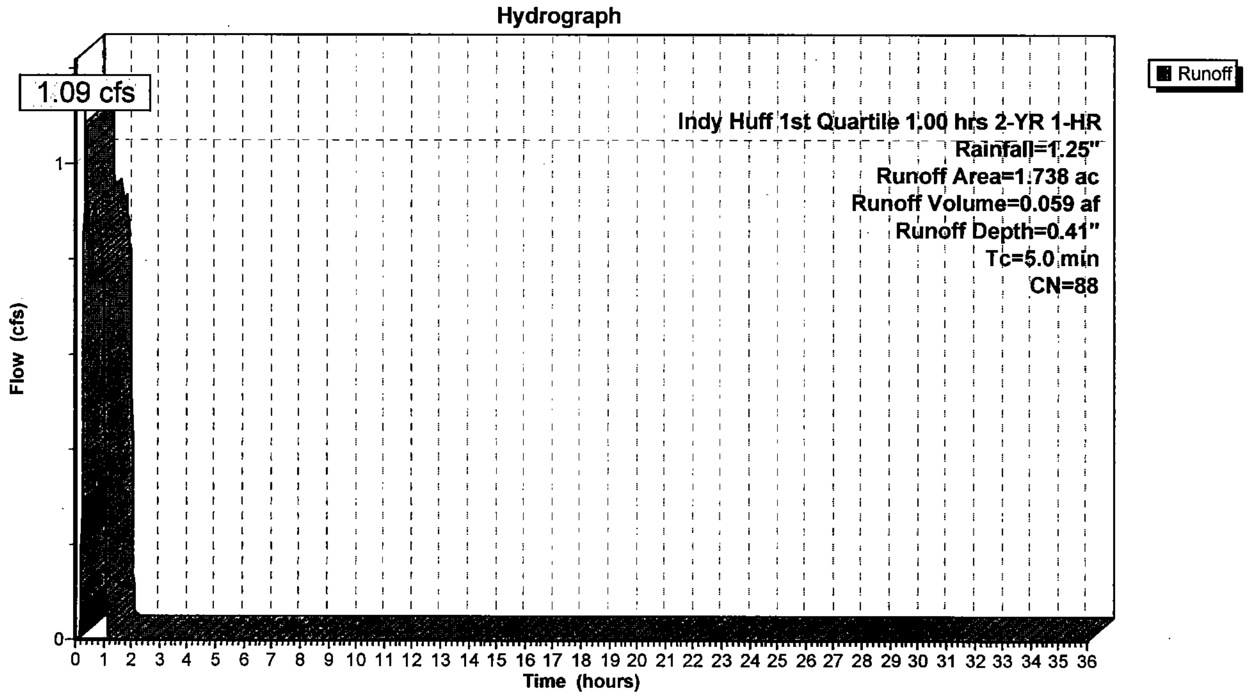
Runoff = 1.09 cfs @ 0.37 hrs, Volume= 0.059 af, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 2-YR 1-HR Rainfall=1.25"

Area (ac)	CN	Description
0.055	98	Paved parking & roofs
0.888	84	50-75% Grass cover, Fair, HSG D
0.795	91	Gravel roads, HSG D
1.738	88	Weighted Average
1.683		Pervious Area
0.055		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: AREA TO BASIN 2



Summary for Subcatchment 4S: UNMANAGED AREA

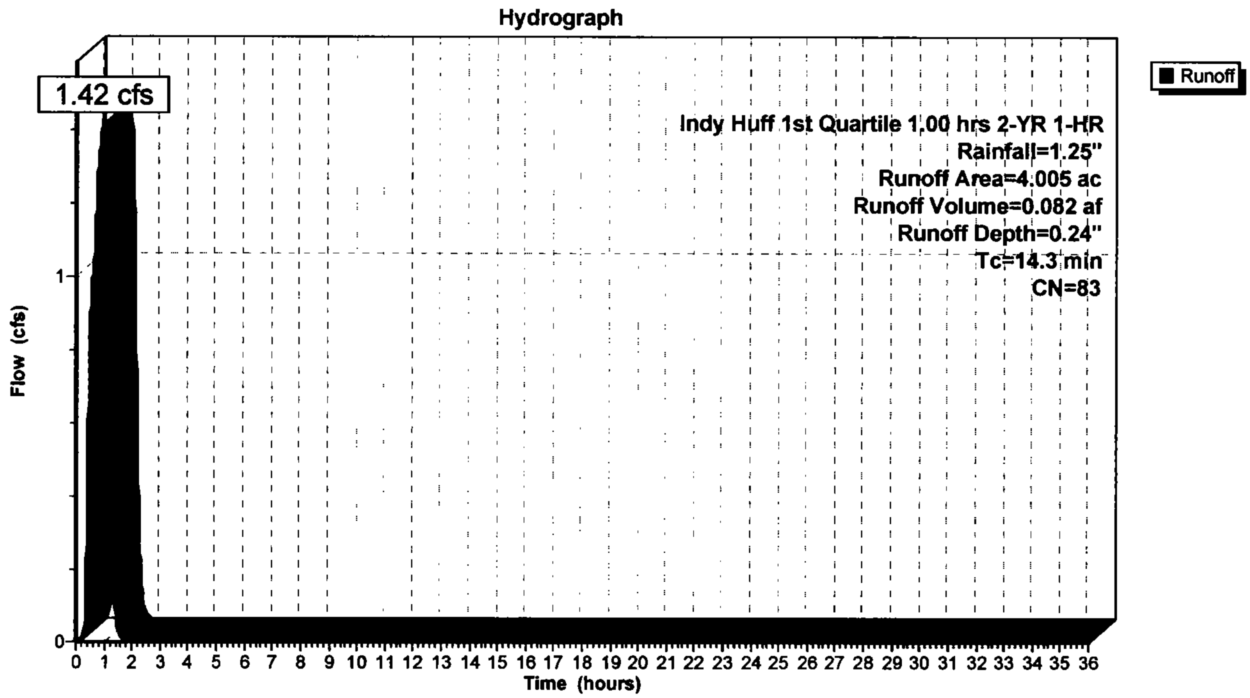
Runoff = 1.42 cfs @ 0.97 hrs, Volume= 0.082 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 2-YR 1-HR Rainfall=1.25"

Area (ac)	CN	Description
2.819	84	50-75% Grass cover, Fair, HSG D
0.300	91	Gravel roads, HSG D
0.886	77	Woods, Good, HSG D
4.005	83	Weighted Average
4.005		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry,**

Subcatchment 4S: UNMANAGED AREA



Summary for Subcatchment 9S: AREA TO BASIN 2

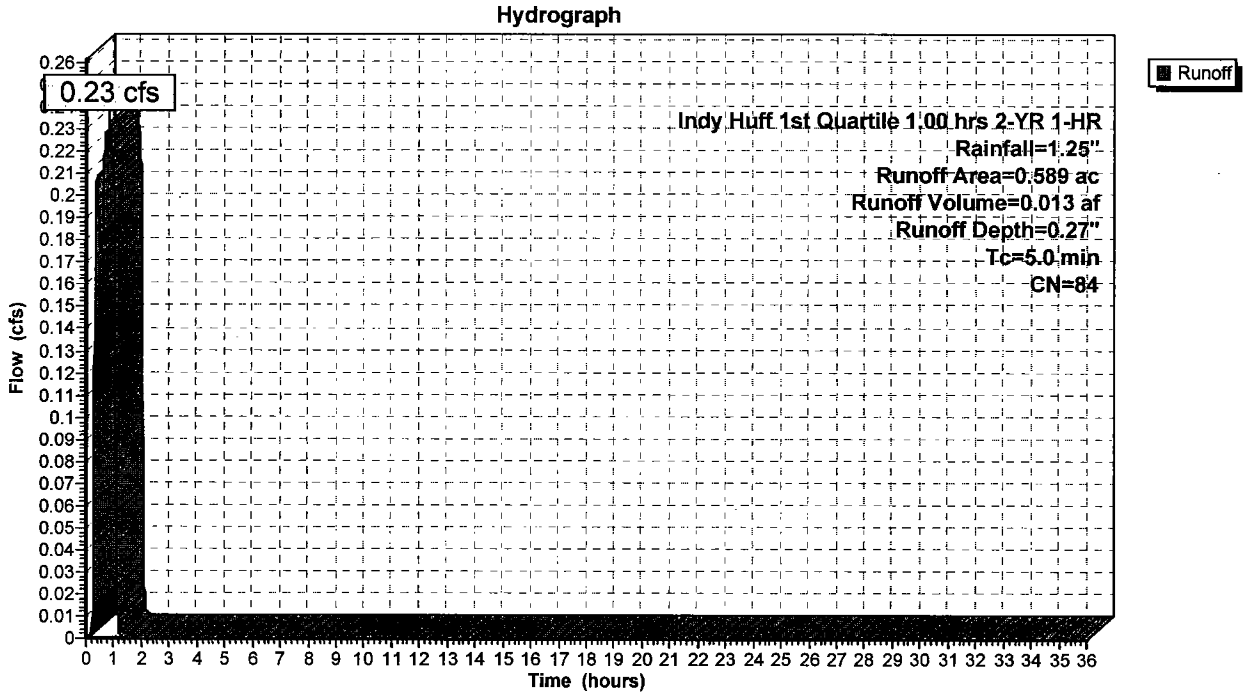
Runoff = 0.23 cfs @ 0.86 hrs, Volume= 0.013 af, Depth= 0.27"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 2-YR 1-HR Rainfall=1.25"

	Area (ac)	CN	Description
*	0.550	84	50-75% Grass Cover, Fair, HSG D
*	0.039	91	Gravel
	0.589	84	Weighted Average
	0.589		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: AREA TO BASIN 2



Summary for Pond 5P: BASIN 1

[87] Warning: Oscillations may require Finer Routing or smaller dt

Inflow Area =	3.920 ac,	18.80% Impervious,	Inflow Depth =	0.54"	for 2-YR 1-HR event
Inflow =	3.57 cfs @	0.35 hrs,	Volume=	0.177 af	
Outflow =	2.44 cfs @	0.48 hrs,	Volume=	0.178 af,	Atten= 32%, Lag= 7.8 min
Primary =	2.44 cfs @	0.48 hrs,	Volume=	0.178 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.18' @ 0.48 hrs Surf.Area= 5,803 sf Storage= 806 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 4.5 min (41.5 - 37.1)

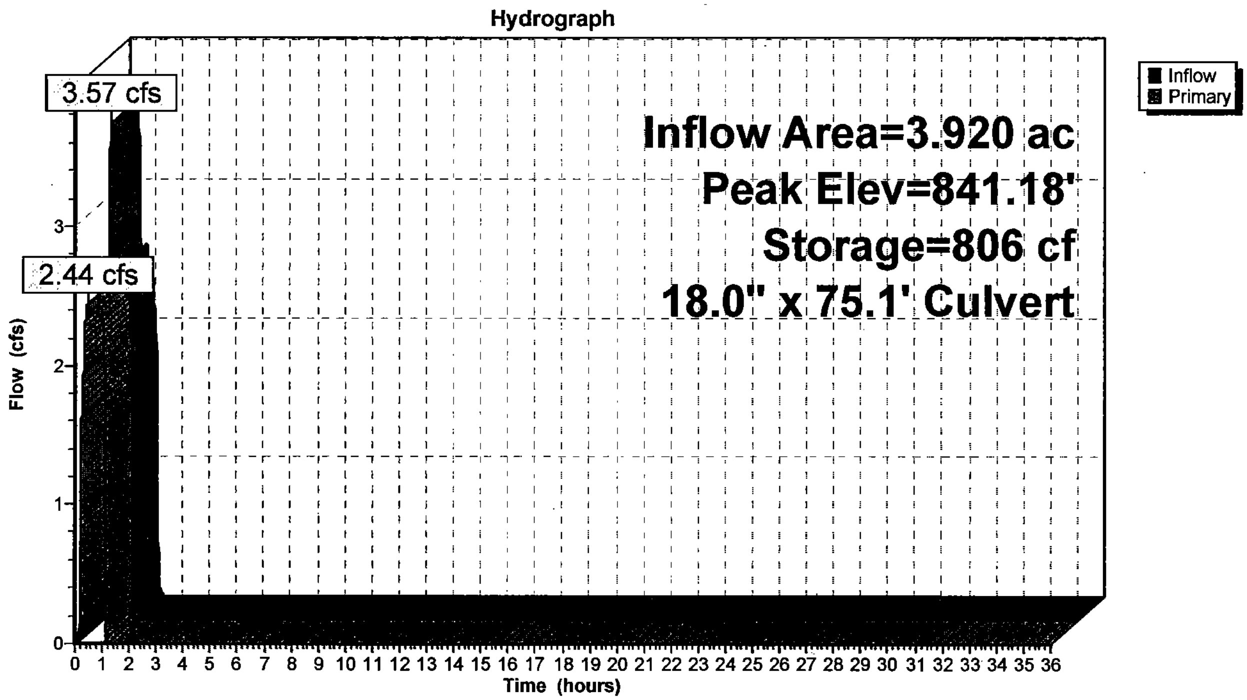
Volume	Invert	Avail.Storage	Storage Description
#1	841.00'	93,677 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
841.00	2,922	0	0
842.00	18,515	10,719	10,719
843.00	42,406	30,461	41,179
844.00	62,589	52,498	93,677

Device	Routing	Invert	Outlet Devices
#1	Primary	840.30'	**18.0" x 75.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.00' S= 0.0040 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=2.44 cfs @ 0.48 hrs HW=841.18' TW=839.17' (Dynamic Tailwater)
1=Culvert (Barrel Controls 2.44 cfs @ 3.24 fps)

Pond 5P: BASIN 1



Summary for Pond 6P: POCKET WETLAND

Inflow Area = 1.738 ac, 3.16% Impervious, Inflow Depth = 0.41" for 2-YR 1-HR event
Inflow = 1.09 cfs @ 0.37 hrs, Volume= 0.059 af
Outflow = 0.20 cfs @ 1.09 hrs, Volume= 0.055 af, Atten= 81%, Lag= 43.3 min
Primary = 0.20 cfs @ 1.09 hrs, Volume= 0.055 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 840.80' @ 1.09 hrs Surf.Area= 7,721 sf Storage= 2,297 cf

Plug-Flow detention time= 301.8 min calculated for 0.055 af (93% of inflow)
Center-of-Mass det. time= 300.4 min (339.6 - 39.1)

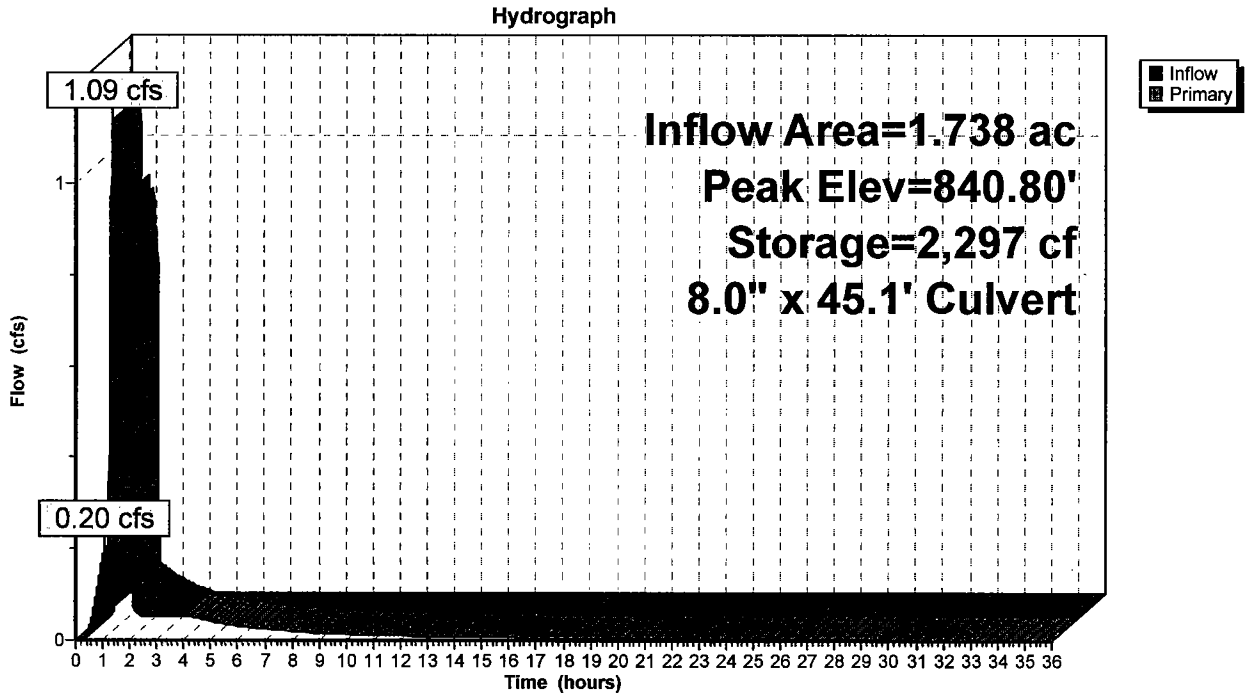
Volume	Invert	Avail.Storage	Storage Description
#1	840.50'	36,708 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
840.50	7,342	0	0
841.00	7,963	3,826	3,826
842.00	13,900	10,932	14,758
843.00	30,000	21,950	36,708

Device	Routing	Invert	Outlet Devices
#1	Primary	840.50'	**8.0" x 45.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.30' S= 0.0044 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=0.20 cfs @ 1.09 hrs HW=840.80' TW=839.57' (Dynamic Tailwater)
1=Culvert (Barrel Controls 0.20 cfs @ 1.91 fps)

Pond 6P: POCKET WETLAND



Summary for Pond 7P: BASIN 2

Inflow Area = 6.247 ac, 12.68% Impervious, Inflow Depth > 0.47" for 2-YR 1-HR event
Inflow = 2.77 cfs @ 0.89 hrs, Volume= 0.246 af
Outflow = 2.22 cfs @ 1.11 hrs, Volume= 0.246 af, Atten= 20%, Lag= 13.0 min
Primary = 2.22 cfs @ 1.11 hrs, Volume= 0.246 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 839.57' @ 1.11 hrs Surf.Area= 6,095 sf Storage= 4,144 cf

Plug-Flow detention time= 37.3 min calculated for 0.246 af (100% of inflow)
Center-of-Mass det. time= 36.5 min (144.5 - 108.0)

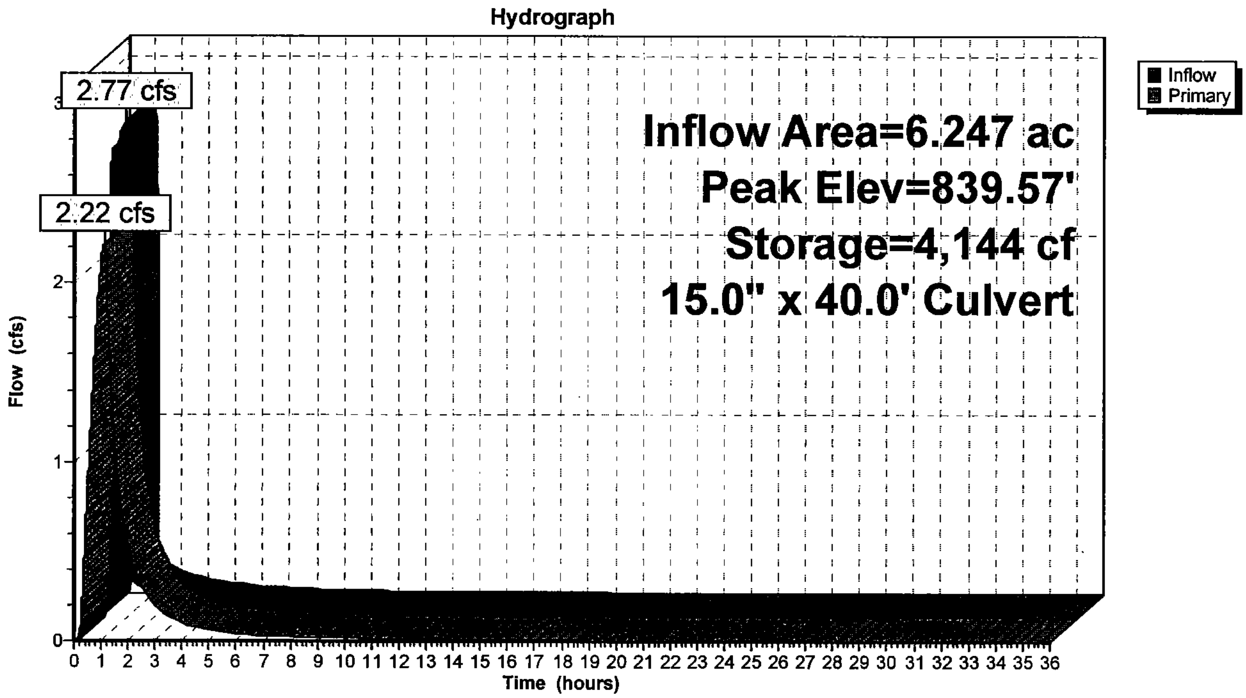
Volume	Invert	Avail.Storage	Storage Description
#1	838.70'	26,266 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
838.70	0	0	0
839.00	5,568	835	835
840.00	6,496	6,032	6,867
841.00	7,484	6,990	13,857
842.00	8,531	8,008	21,865
842.50	9,076	4,402	26,266

Device	Routing	Invert	Outlet Devices
#1	Primary	838.70'	**15.0" x 40.0' long Culvert** RCP, sq.cut end projecting, Ke= 0.500 Outlet Invert= 838.50' S= 0.0050 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=2.22 cfs @ 1.11 hrs HW=839.57' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 2.22 cfs @ 3.44 fps)

Pond 7P: BASIN 2

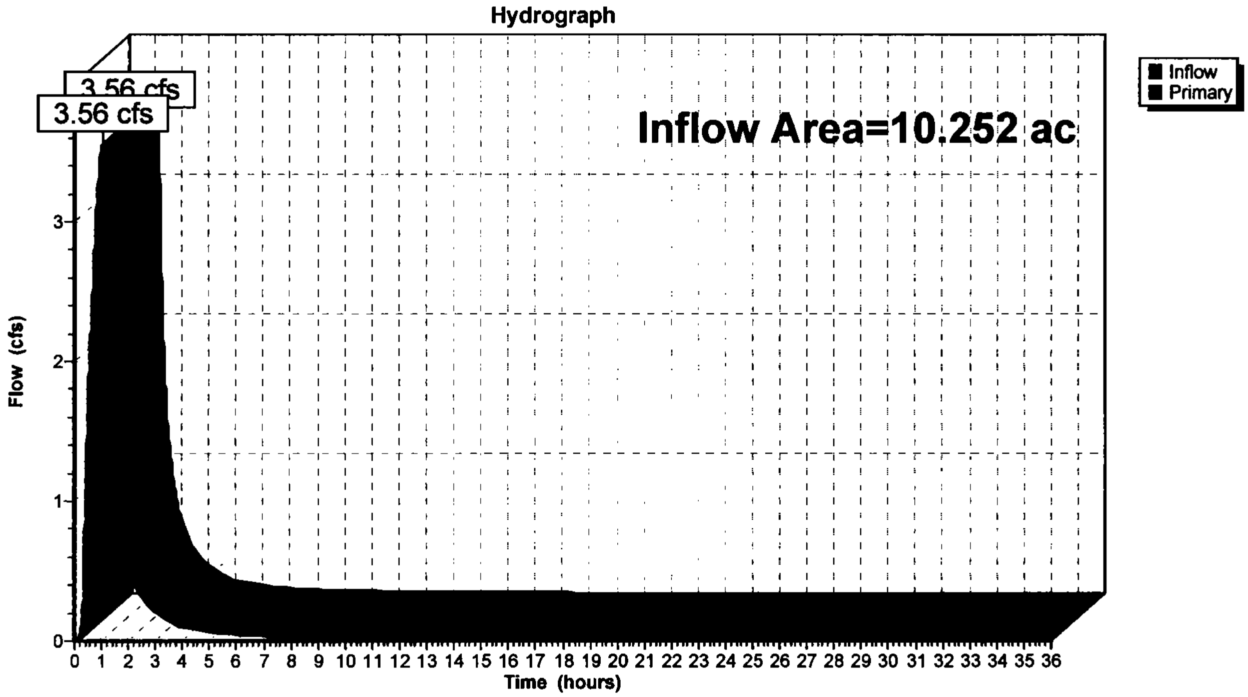


Summary for Link 8L: TOTAL POSTDEVELOPED

Inflow Area =	10.252 ac,	7.73% Impervious,	Inflow Depth >	0.38"	for 2-YR 1-HR event
Inflow =	3.56 cfs @	1.04 hrs,	Volume=	0.327 af	
Primary =	3.56 cfs @	1.04 hrs,	Volume=	0.327 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 8L: TOTAL POSTDEVELOPED



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 2S: AREA TO BASIN 1	Runoff Area=3.920 ac 18.80% Impervious Runoff Depth=1.13" Tc=5.0 min CN=91 Runoff=8.13 cfs 0.369 af
Subcatchment 3S: AREA TO BASIN 2	Runoff Area=1.738 ac 3.16% Impervious Runoff Depth=0.93" Tc=5.0 min CN=88 Runoff=2.81 cfs 0.135 af
Subcatchment 4S: UNMANAGED AREA	Runoff Area=4.005 ac 0.00% Impervious Runoff Depth=0.67" Tc=14.3 min CN=83 Runoff=3.28 cfs 0.223 af
Subcatchment 9S: AREA TO BASIN 2	Runoff Area=0.589 ac 0.00% Impervious Runoff Depth=0.72" Tc=5.0 min CN=84 Runoff=0.67 cfs 0.035 af
Pond 5P: BASIN 1	Peak Elev=841.55' Storage=3,909 cf Inflow=8.13 cfs 0.369 af 18.0" x 75.1' Culvert Outflow=4.27 cfs 0.369 af
Pond 6P: POCKET WETLAND	Peak Elev=841.12' Storage=4,785 cf Inflow=2.81 cfs 0.135 af 8.0" x 45.1' Culvert Outflow=0.65 cfs 0.131 af
Pond 7P: BASIN 2	Peak Elev=840.06' Storage=7,284 cf Inflow=5.32 cfs 0.535 af 15.0" x 40.0' Culvert Outflow=4.37 cfs 0.534 af
Link 8L: TOTAL POSTDEVELOPED	Inflow=7.38 cfs 0.757 af Primary=7.38 cfs 0.757 af

Total Runoff Area = 10.252 ac Runoff Volume = 0.762 af Average Runoff Depth = 0.89"
92.27% Pervious = 9.460 ac 7.73% Impervious = 0.792 ac

Summary for Subcatchment 2S: AREA TO BASIN 1

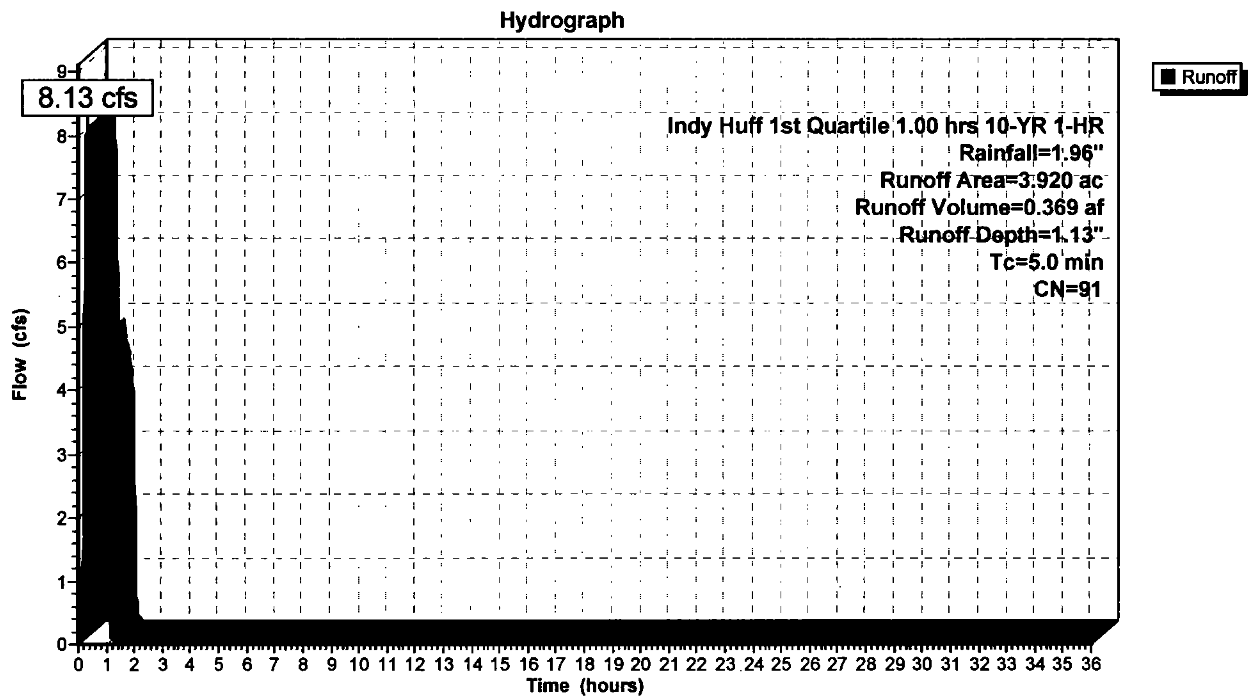
Runoff = 8.13 cfs @ 0.32 hrs, Volume= 0.369 af, Depth= 1.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 10-YR 1-HR Rainfall=1.96"

	Area (ac)	CN	Description
	0.737	98	Paved parking & roofs
	2.629	91	Gravel roads, HSG D
*	0.554	84	50-75% Grass Cover, Fair, HSG D
	3.920	91	Weighted Average
	3.183		Pervious Area
	0.737		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: AREA TO BASIN 1



Summary for Subcatchment 3S: AREA TO BASIN 2

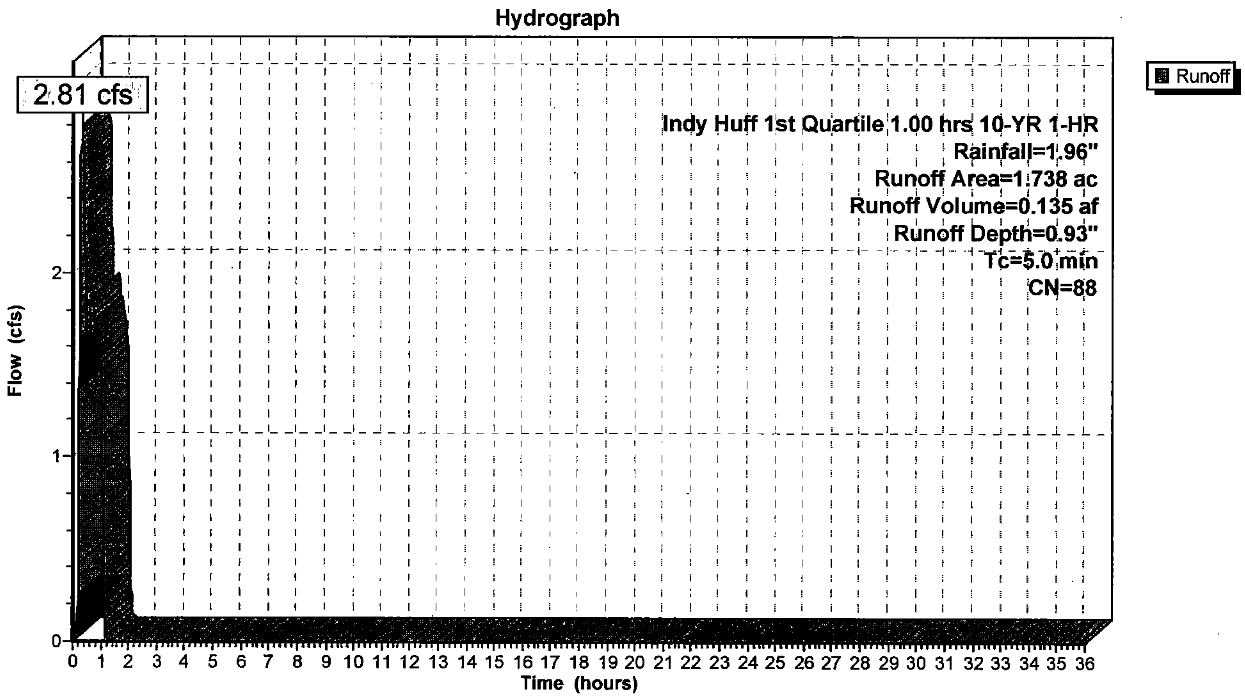
Runoff = 2.81 cfs @ 0.34 hrs, Volume= 0.135 af, Depth= 0.93"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 10-YR 1-HR Rainfall=1.96"

Area (ac)	CN	Description
0.055	98	Paved parking & roofs
0.888	84	50-75% Grass cover, Fair, HSG D
0.795	91	Gravel roads, HSG D
1.738	88	Weighted Average
1.683		Pervious Area
0.055		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: AREA TO BASIN 2



Summary for Subcatchment 4S: UNMANAGED AREA

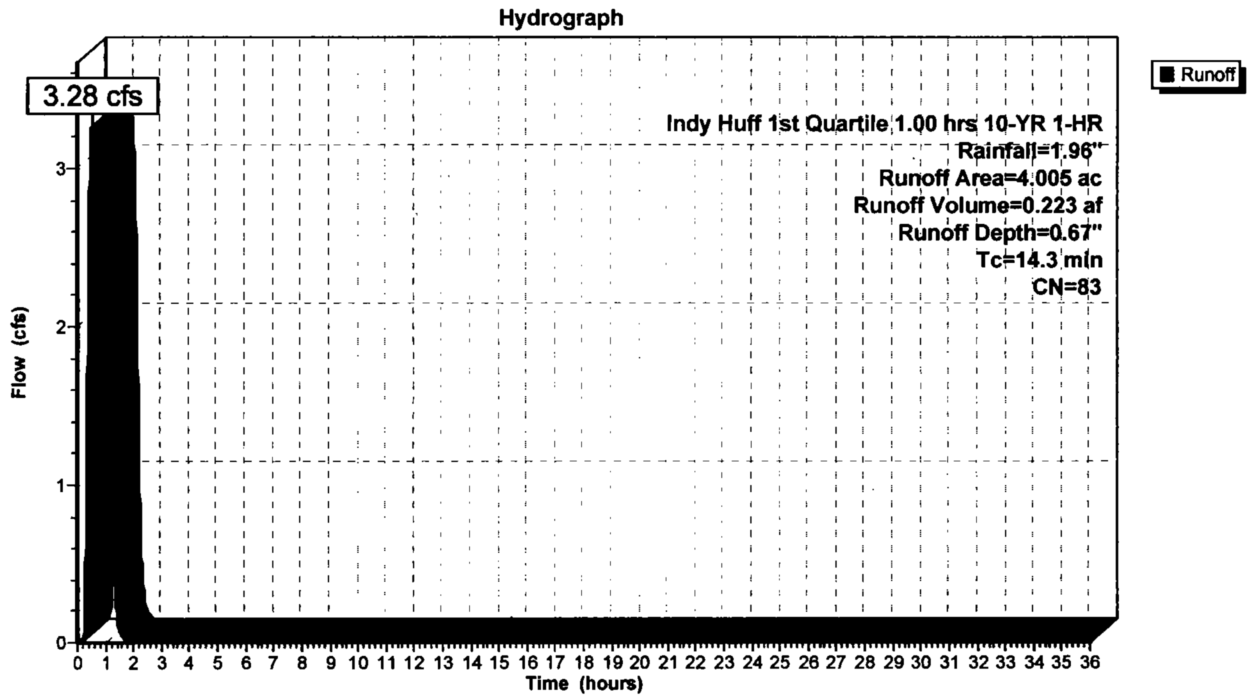
Runoff = 3.28 cfs @ 0.52 hrs, Volume= 0.223 af, Depth= 0.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 10-YR 1-HR Rainfall=1.96"

Area (ac)	CN	Description
2.819	84	50-75% Grass cover, Fair, HSG D
0.300	91	Gravel roads, HSG D
0.886	77	Woods, Good, HSG D
4.005	83	Weighted Average
4.005		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry,**

Subcatchment 4S: UNMANAGED AREA



Summary for Subcatchment 9S: AREA TO BASIN 2

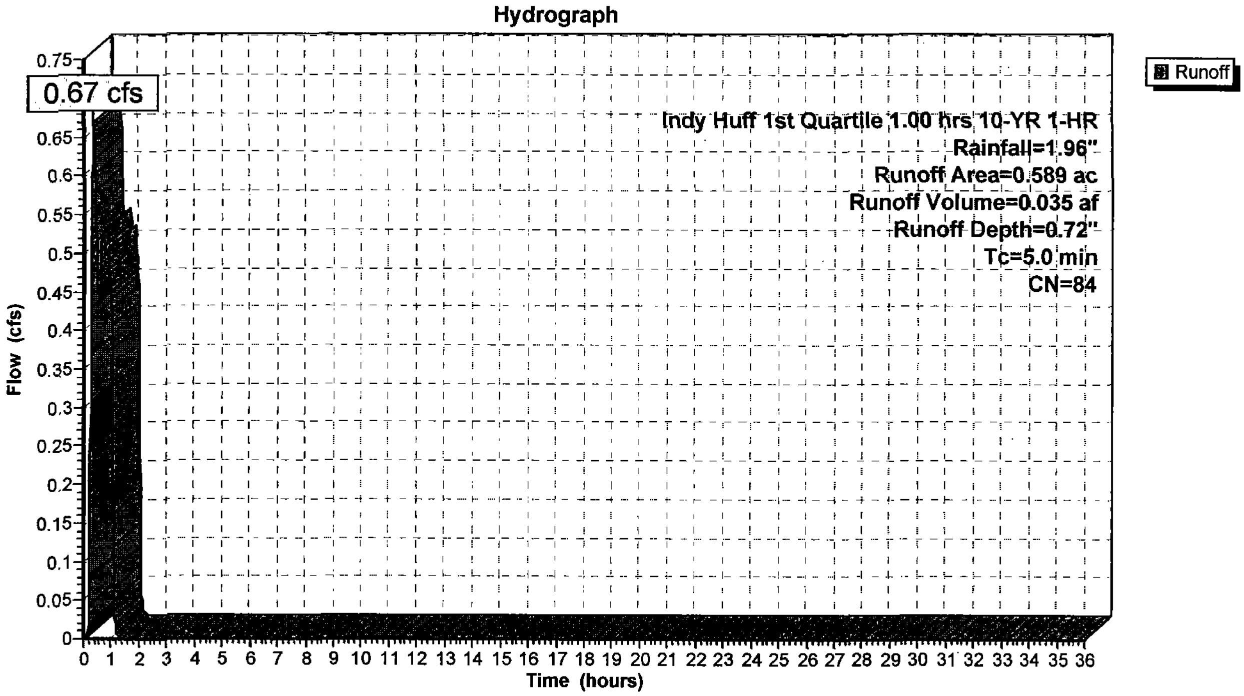
Runoff = 0.67 cfs @ 0.36 hrs, Volume= 0.035 af, Depth= 0.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 10-YR 1-HR Rainfall=1.96"

	Area (ac)	CN	Description
*	0.550	84	50-75% Grass Cover, Fair, HSG D
*	0.039	91	Gravel
	0.589	84	Weighted Average
	0.589		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: AREA TO BASIN 2



Summary for Pond 5P: BASIN 1

Inflow Area = 3.920 ac, 18.80% Impervious, Inflow Depth = 1.13" for 10-YR 1-HR event
Inflow = 8.13 cfs @ 0.32 hrs, Volume= 0.369 af
Outflow = 4.27 cfs @ 0.89 hrs, Volume= 0.369 af, Atten= 48%, Lag= 34.2 min
Primary = 4.27 cfs @ 0.89 hrs, Volume= 0.369 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.55' @ 0.89 hrs Surf.Area= 11,421 sf Storage= 3,909 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 12.5 min (47.3 - 34.8)

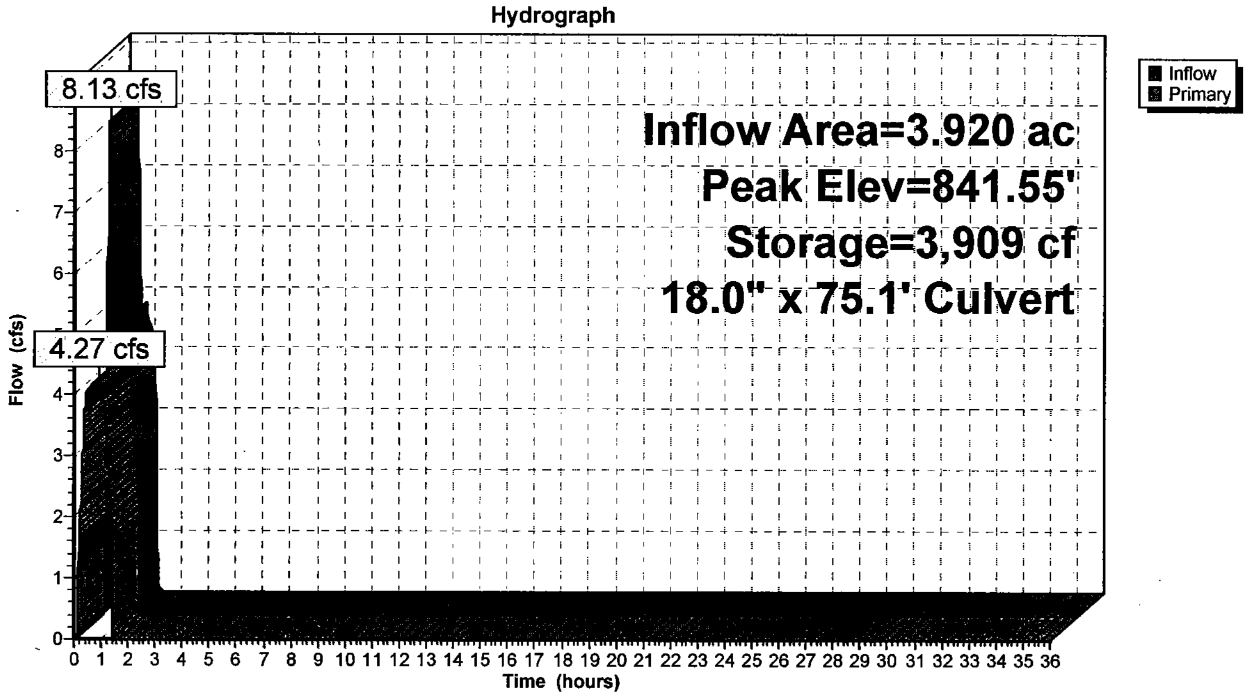
Volume	Invert	Avail.Storage	Storage Description
#1	841.00'	93,677 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
841.00	2,922	0	0
842.00	18,515	10,719	10,719
843.00	42,406	30,461	41,179
844.00	62,589	52,498	93,677

Device	Routing	Invert	Outlet Devices
#1	Primary	840.30'	**18.0" x 75.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.00' S= 0.0040 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=4.27 cfs @ 0.89 hrs HW=841.55' TW=839.94' (Dynamic Tailwater)
1=Culvert (Barrel Controls 4.27 cfs @ 3.69 fps)

Pond 5P: BASIN 1



Summary for Pond 6P: POCKET WETLAND

Inflow Area = 1.738 ac, 3.16% Impervious, Inflow Depth = 0.93" for 10-YR 1-HR event
Inflow = 2.81 cfs @ 0.34 hrs, Volume= 0.135 af
Outflow = 0.65 cfs @ 1.07 hrs, Volume= 0.131 af, Atten= 77%, Lag= 44.1 min
Primary = 0.65 cfs @ 1.07 hrs, Volume= 0.131 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.12' @ 1.07 hrs Surf.Area= 8,649 sf Storage= 4,785 cf

Plug-Flow detention time= 199.1 min calculated for 0.131 af (97% of inflow)
Center-of-Mass det. time= 198.2 min (234.5 - 36.4)

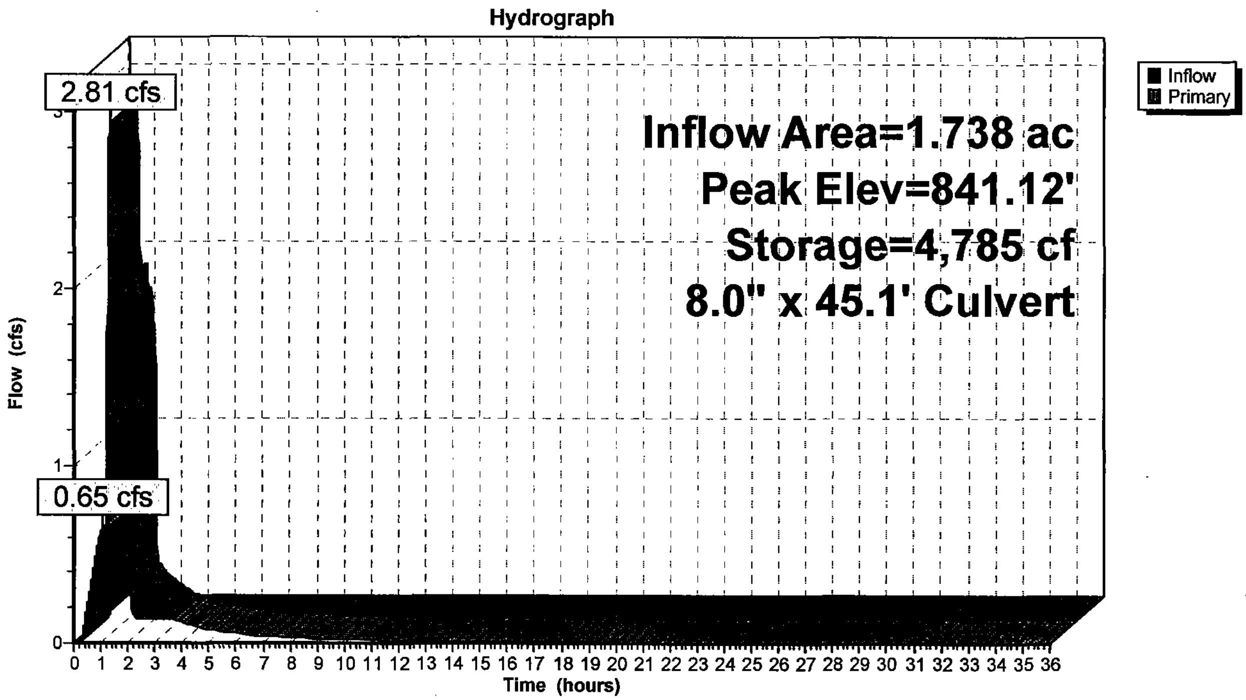
Volume	Invert	Avail.Storage	Storage Description
#1	840.50'	36,708 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
840.50	7,342	0	0
841.00	7,963	3,826	3,826
842.00	13,900	10,932	14,758
843.00	30,000	21,950	36,708

Device	Routing	Invert	Outlet Devices
#1	Primary	840.50'	**8.0" x 45.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.30' S= 0.0044 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=0.65 cfs @ 1.07 hrs HW=841.12' TW=840.05' (Dynamic Tailwater)
1=Culvert (Barrel Controls 0.65 cfs @ 2.53 fps)

Pond 6P: POCKET WETLAND



Summary for Pond 7P: BASIN 2

Inflow Area = 6.247 ac, 12.68% Impervious, Inflow Depth > 1.03" for 10-YR 1-HR event
Inflow = 5.32 cfs @ 0.90 hrs, Volume= 0.535 af
Outflow = 4.37 cfs @ 1.14 hrs, Volume= 0.534 af, Atten= 18%, Lag= 14.1 min
Primary = 4.37 cfs @ 1.14 hrs, Volume= 0.534 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 840.06' @ 1.14 hrs Surf.Area= 6,559 sf Storage= 7,284 cf

Plug-Flow detention time= 32.6 min calculated for 0.534 af (100% of inflow)
Center-of-Mass det. time= 32.1 min (124.6 - 92.5)

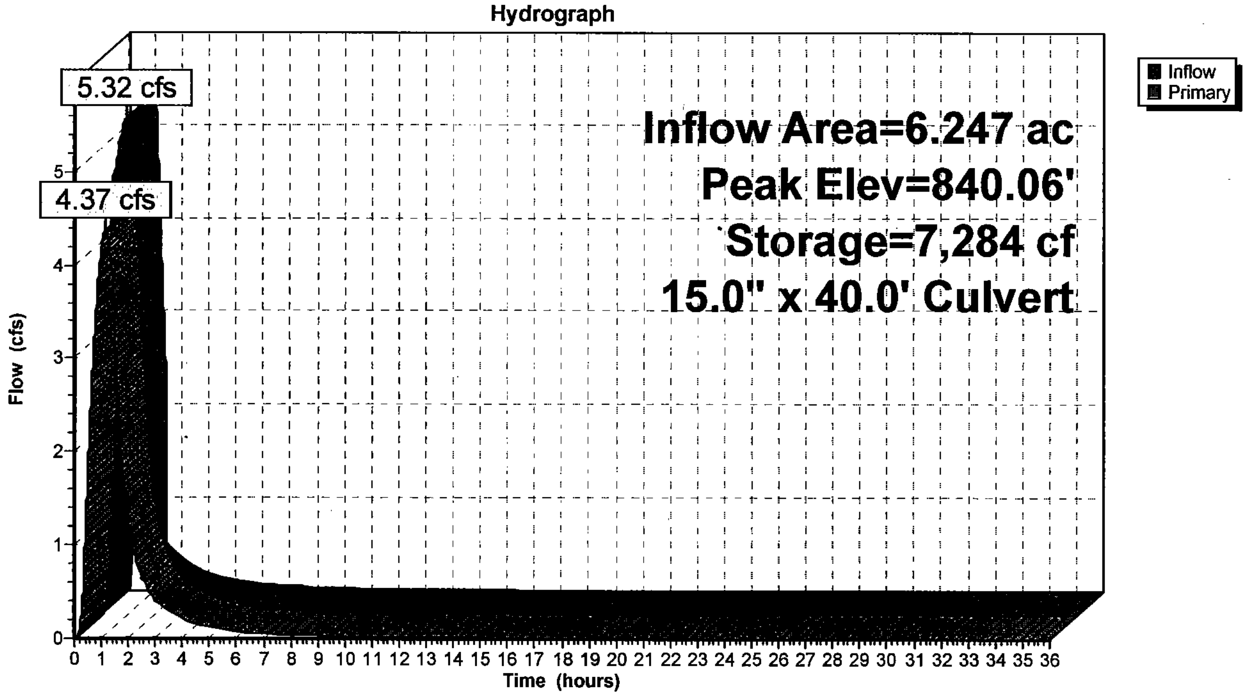
Volume	Invert	Avail.Storage	Storage Description
#1	838.70'	26,266 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
838.70	0	0	0
839.00	5,568	835	835
840.00	6,496	6,032	6,867
841.00	7,484	6,990	13,857
842.00	8,531	8,008	21,865
842.50	9,076	4,402	26,266

Device	Routing	Invert	Outlet Devices
#1	Primary	838.70'	**15.0" x 40.0' long Culvert** RCP, sq.cut end projecting, Ke= 0.500 Outlet Invert= 838.50' S= 0.0050 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=4.37 cfs @ 1.14 hrs HW=840.06' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 4.37 cfs @ 4.06 fps)

Pond 7P: BASIN 2

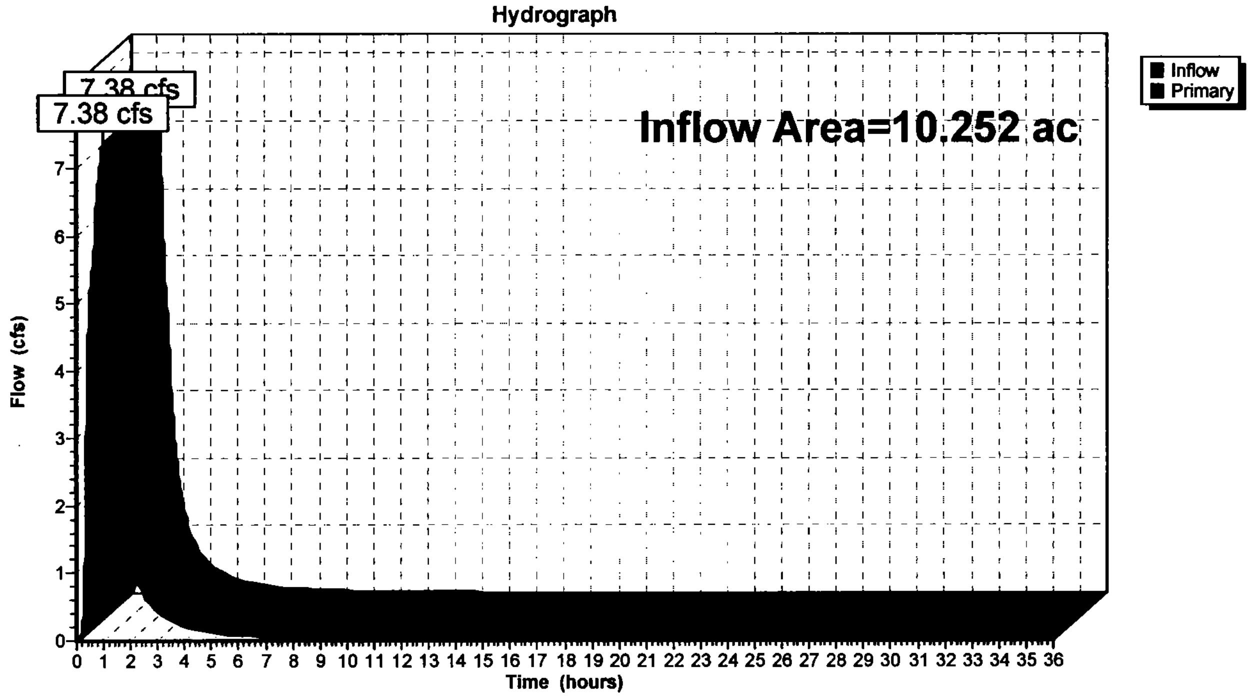


Summary for Link 8L: TOTAL POSTDEVELOPED

Inflow Area =	10.252 ac,	7.73% Impervious,	Inflow Depth > 0.89"	for 10-YR 1-HR event	
Inflow =	7.38 cfs @	1.02 hrs,	Volume=	0.757 af	
Primary =	7.38 cfs @	1.02 hrs,	Volume=	0.757 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 8L: TOTAL POSTDEVELOPED



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment2S: AREA TO BASIN 1 Runoff Area=3.920 ac 18.80% Impervious Runoff Depth=1.44"
Tc=5.0 min CN=91 Runoff=10.64 cfs 0.470 af

Subcatchment3S: AREA TO BASIN 2 Runoff Area=1.738 ac 3.16% Impervious Runoff Depth=1.22"
Tc=5.0 min CN=88 Runoff=3.79 cfs 0.177 af

Subcatchment4S: UNMANAGED AREA Runoff Area=4.005 ac 0.00% Impervious Runoff Depth=0.91"
Tc=14.3 min CN=83 Runoff=4.71 cfs 0.305 af

Subcatchment9S: AREA TO BASIN 2 Runoff Area=0.589 ac 0.00% Impervious Runoff Depth=0.97"
Tc=5.0 min CN=84 Runoff=0.95 cfs 0.048 af

Pond 5P: BASIN 1 Peak Elev=841.71' Storage=5,945 cf Inflow=10.64 cfs 0.470 af
18.0" x 75.1' Culvert Outflow=5.11 cfs 0.470 af

Pond 6P: POCKET WETLAND Peak Elev=841.26' Storage=6,104 cf Inflow=3.79 cfs 0.177 af
8.0" x 45.1' Culvert Outflow=0.85 cfs 0.172 af

Pond 7P: BASIN 2 Peak Elev=840.32' Storage=8,975 cf Inflow=6.51 cfs 0.690 af
15.0" x 40.0' Culvert Outflow=5.13 cfs 0.690 af

Link 8L: TOTAL POSTDEVELOPED Inflow=9.11 cfs 0.995 af
Primary=9.11 cfs 0.995 af

Total Runoff Area = 10.252 ac Runoff Volume = 1.000 af Average Runoff Depth = 1.17"
92.27% Pervious = 9.460 ac 7.73% Impervious = 0.792 ac

Summary for Subcatchment 2S: AREA TO BASIN 1

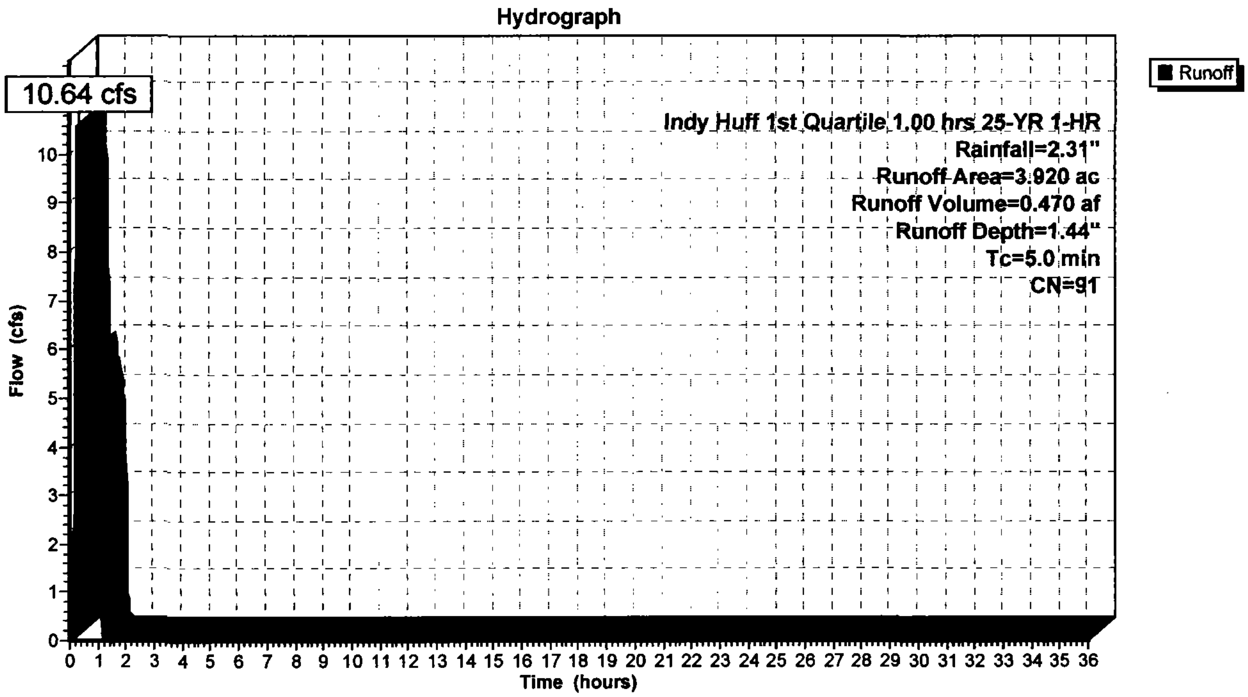
Runoff = 10.64 cfs @ 0.31 hrs, Volume= 0.470 af, Depth= 1.44"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 25-YR 1-HR Rainfall=2.31"

	Area (ac)	CN	Description
	0.737	98	Paved parking & roofs
	2.629	91	Gravel roads, HSG D
*	0.554	84	50-75% Grass Cover, Fair, HSG D
	3.920	91	Weighted Average
	3.183		Pervious Area
	0.737		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: AREA TO BASIN 1



Summary for Subcatchment 3S: AREA TO BASIN 2

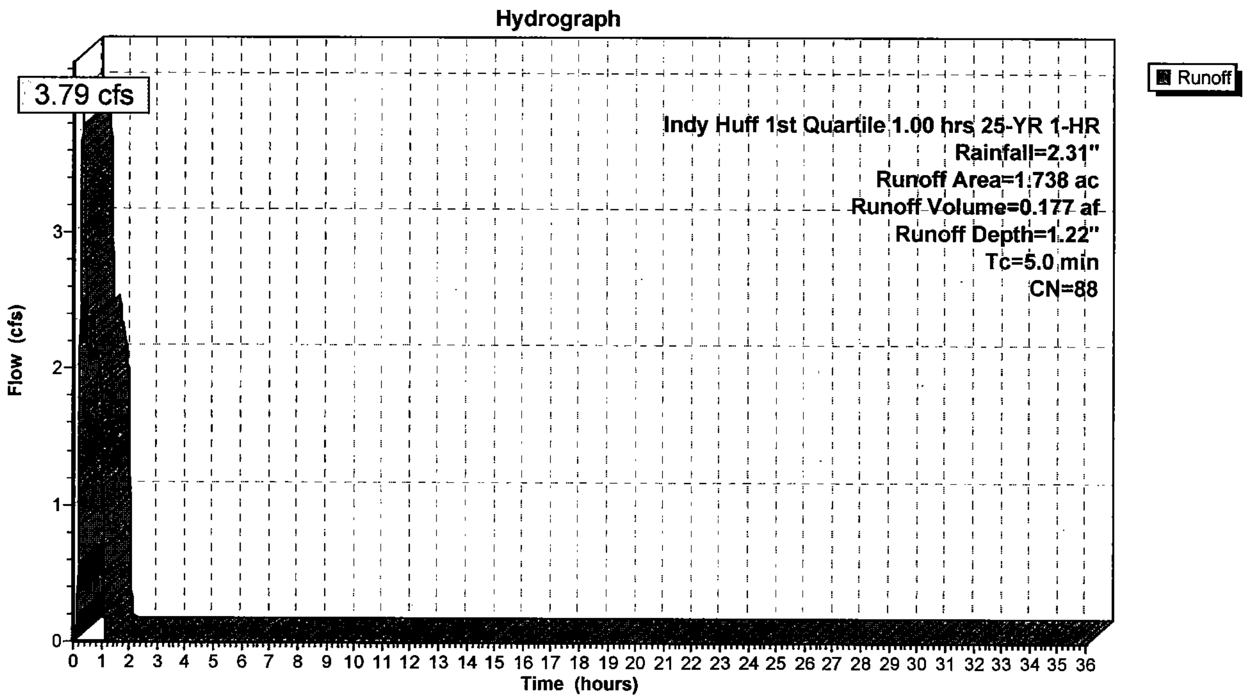
Runoff = 3.79 cfs @ 0.33 hrs, Volume= 0.177 af, Depth= 1.22"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 25-YR 1-HR Rainfall=2.31"

Area (ac)	CN	Description
0.055	98	Paved parking & roofs
0.888	84	50-75% Grass cover, Fair, HSG D
0.795	91	Gravel roads, HSG D
1.738	88	Weighted Average
1.683		Pervious Area
0.055		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: AREA TO BASIN 2



Summary for Subcatchment 4S: UNMANAGED AREA

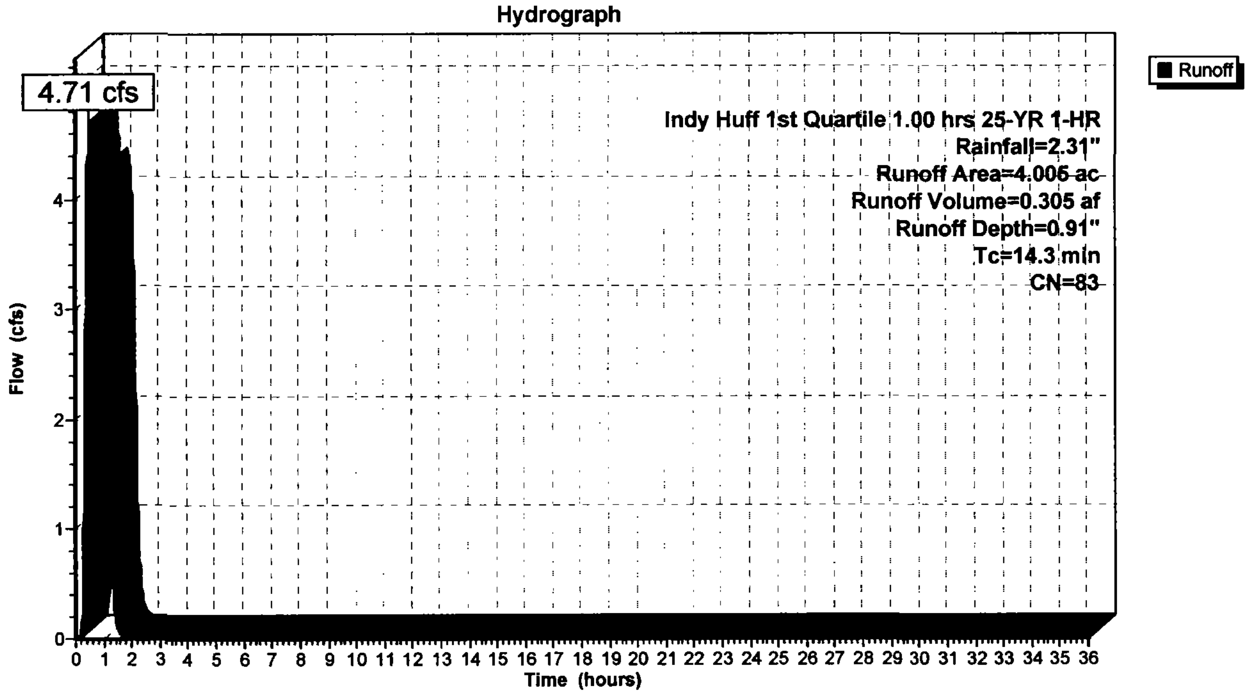
Runoff = 4.71 cfs @ 0.50 hrs, Volume= 0.305 af, Depth= 0.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 25-YR 1-HR Rainfall=2.31"

Area (ac)	CN	Description
2.819	84	50-75% Grass cover, Fair, HSG D
0.300	91	Gravel roads, HSG D
0.886	77	Woods, Good, HSG D
4.005	83	Weighted Average
4.005		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry,**

Subcatchment 4S: UNMANAGED AREA



Summary for Subcatchment 9S: AREA TO BASIN 2

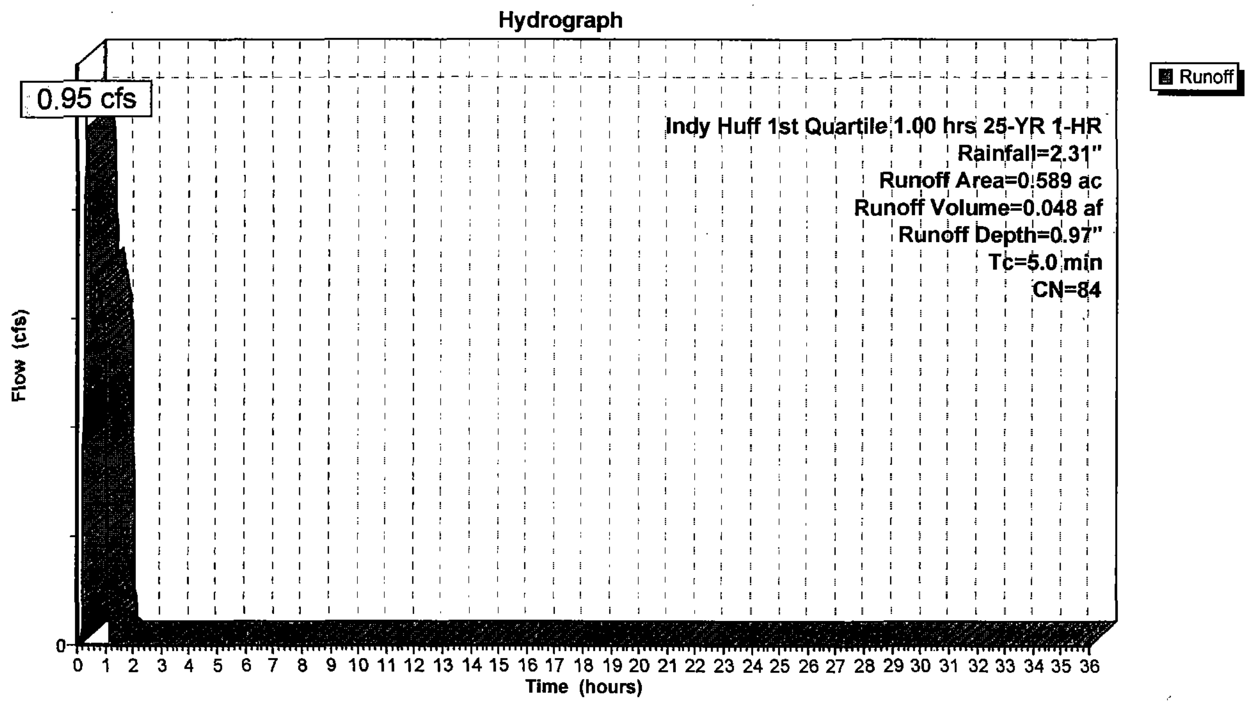
Runoff = 0.95 cfs @ 0.35 hrs, Volume= 0.048 af, Depth= 0.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 25-YR 1-HR Rainfall=2.31"

	Area (ac)	CN	Description
*	0.550	84	50-75% Grass Cover, Fair, HSG D
*	0.039	91	Gravel
	0.589	84	Weighted Average
	0.589		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: AREA TO BASIN 2



Summary for Pond 5P: BASIN 1

Inflow Area = 3.920 ac, 18.80% Impervious, Inflow Depth = 1.44" for 25-YR 1-HR event
Inflow = 10.64 cfs @ 0.31 hrs, Volume= 0.470 af
Outflow = 5.11 cfs @ 0.90 hrs, Volume= 0.470 af, Atten= 52%, Lag= 35.5 min
Primary = 5.11 cfs @ 0.90 hrs, Volume= 0.470 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.71' @ 0.90 hrs Surf.Area= 13,927 sf Storage= 5,945 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 15.7 min (49.8 - 34.1)

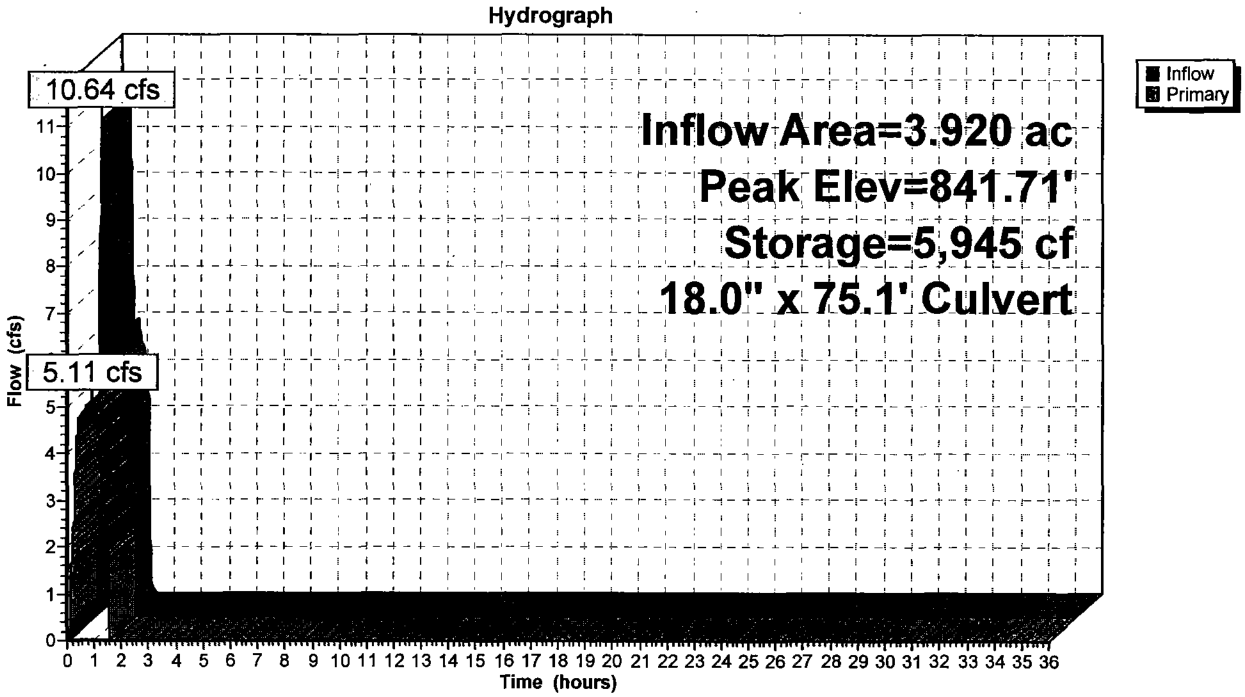
Volume	Invert	Avail.Storage	Storage Description
#1	841.00'	93,677 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
841.00	2,922	0	0
842.00	18,515	10,719	10,719
843.00	42,406	30,461	41,179
844.00	62,589	52,498	93,677

Device	Routing	Invert	Outlet Devices
#1	Primary	840.30'	**18.0" x 75.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.00' S= 0.0040 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=5.11 cfs @ 0.90 hrs HW=841.71' TW=840.16' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 5.11 cfs @ 3.85 fps)

Pond 5P: BASIN 1



Summary for Pond 6P: POCKET WETLAND

Inflow Area =	1.738 ac,	3.16% Impervious,	Inflow Depth = 1.22"	for 25-YR 1-HR event	
Inflow =	3.79 cfs @	0.33 hrs,	Volume=	0.177 af	
Outflow =	0.85 cfs @	1.07 hrs,	Volume=	0.172 af,	Atten= 78%, Lag= 44.6 min
Primary =	0.85 cfs @	1.07 hrs,	Volume=	0.172 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.26' @ 1.07 hrs Surf.Area= 9,511 sf Storage= 6,104 cf

Plug-Flow detention time= 177.3 min calculated for 0.172 af (97% of inflow)
Center-of-Mass det. time= 176.6 min (212.1 - 35.5)

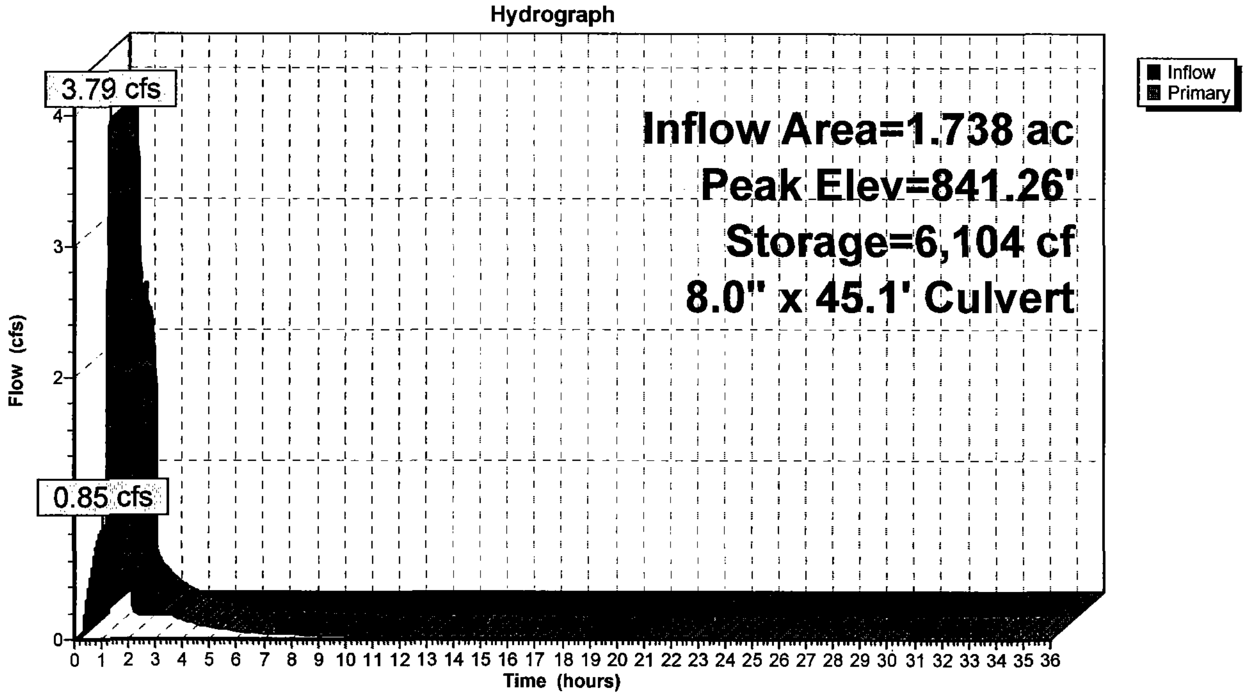
Volume	Invert	Avail.Storage	Storage Description
#1	840.50'	36,708 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
840.50	7,342	0	0
841.00	7,963	3,826	3,826
842.00	13,900	10,932	14,758
843.00	30,000	21,950	36,708

Device	Routing	Invert	Outlet Devices
#1	Primary	840.50'	**8.0" x 45.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.30' S= 0.0044 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=0.85 cfs @ 1.07 hrs HW=841.26' TW=840.29' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.85 cfs @ 2.68 fps)

Pond 6P: POCKET WETLAND



Summary for Pond 7P: BASIN 2

Inflow Area = 6.247 ac, 12.68% Impervious, Inflow Depth > 1.33" for 25-YR 1-HR event
Inflow = 6.51 cfs @ 0.90 hrs, Volume= 0.690 af
Outflow = 5.13 cfs @ 1.18 hrs, Volume= 0.690 af, Atten= 21%, Lag= 16.8 min
Primary = 5.13 cfs @ 1.18 hrs, Volume= 0.690 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 840.32' @ 1.18 hrs Surf.Area= 6,809 sf Storage= 8,975 cf

Plug-Flow detention time= 31.8 min calculated for 0.690 af (100% of inflow)
Center-of-Mass det. time= 31.5 min (120.9 - 89.4)

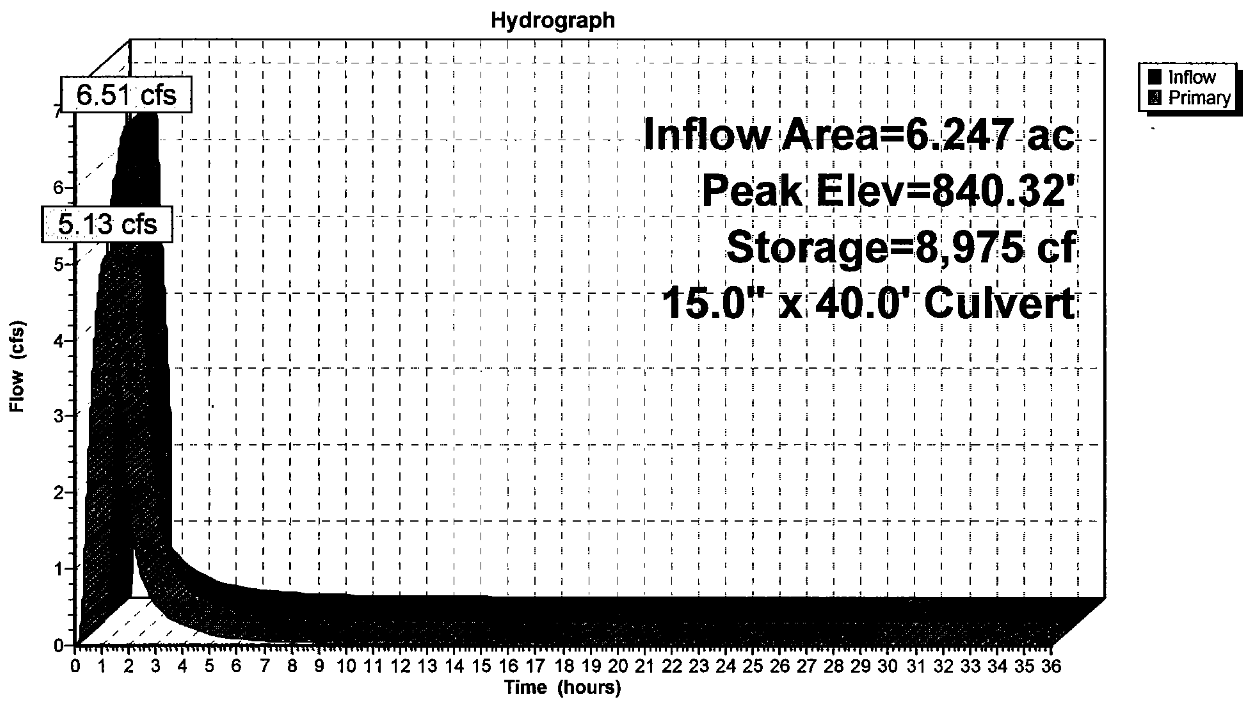
Volume	Invert	Avail.Storage	Storage Description
#1	838.70'	26,266 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
838.70	0	0	0
839.00	5,568	835	835
840.00	6,496	6,032	6,867
841.00	7,484	6,990	13,857
842.00	8,531	8,008	21,865
842.50	9,076	4,402	26,266

Device	Routing	Invert	Outlet Devices
#1	Primary	838.70'	**15.0" x 40.0' long Culvert** RCP, sq.cut end projecting, Ke= 0.500 Outlet Invert= 838.50' S= 0.0050 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=5.13 cfs @ 1.18 hrs HW=840.32' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 5.13 cfs @ 4.22 fps)

Pond 7P: BASIN 2

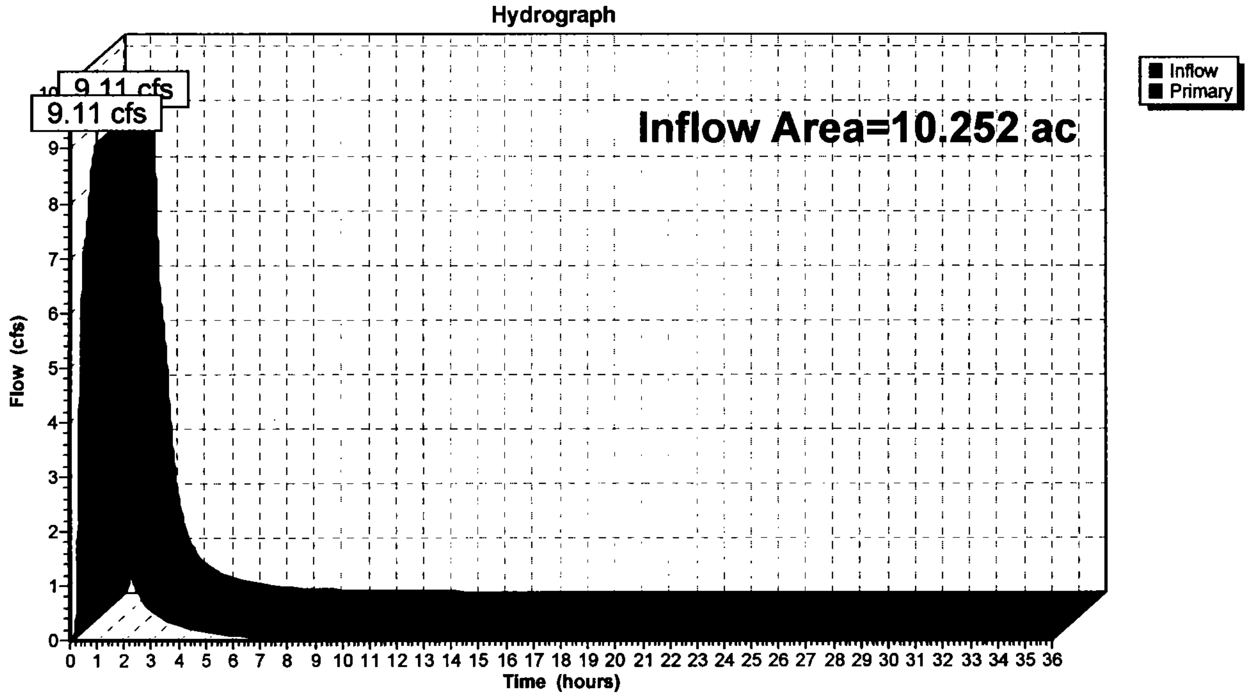


Summary for Link 8L: TOTAL POSTDEVELOPED

Inflow Area =	10.252 ac,	7.73% Impervious,	Inflow Depth > 1.17"		for 25-YR 1-HR event
Inflow =	9.11 cfs @	0.97 hrs,	Volume=	0.995 af	
Primary =	9.11 cfs @	0.97 hrs,	Volume=	0.995 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 8L: TOTAL POSTDEVELOPED



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment2S: AREA TO BASIN 1	Runoff Area=3.920 ac 18.80% Impervious Runoff Depth=1.96" Tc=5.0 min CN=91 Runoff=14.93 cfs 0.640 af
Subcatchment3S: AREA TO BASIN 2	Runoff Area=1.738 ac 3.16% Impervious Runoff Depth=1.71" Tc=5.0 min CN=88 Runoff=5.53 cfs 0.248 af
Subcatchment4S: UNMANAGED AREA	Runoff Area=4.005 ac 0.00% Impervious Runoff Depth=1.35" Tc=14.3 min CN=83 Runoff=7.36 cfs 0.451 af
Subcatchment9S: AREA TO BASIN 2	Runoff Area=0.589 ac 0.00% Impervious Runoff Depth=1.42" Tc=5.0 min CN=84 Runoff=1.46 cfs 0.070 af
Pond 5P: BASIN 1	Peak Elev=841.95' Storage=9,839 cf Inflow=14.93 cfs 0.640 af 18.0" x 75.1' Culvert Outflow=6.32 cfs 0.641 af
Pond 6P: POCKET WETLAND	Peak Elev=841.50' Storage=8,536 cf Inflow=5.53 cfs 0.248 af 8.0" x 45.1' Culvert Outflow=1.03 cfs 0.243 af
Pond 7P: BASIN 2	Peak Elev=840.71' Storage=11,731 cf Inflow=8.12 cfs 0.953 af 15.0" x 40.0' Culvert Outflow=6.37 cfs 0.953 af
Link 8L: TOTAL POSTDEVELOPED	Inflow=11.70 cfs 1.404 af Primary=11.70 cfs 1.404 af

Total Runoff Area = 10.252 ac Runoff Volume = 1.408 af Average Runoff Depth = 1.65"
92.27% Pervious = 9.460 ac 7.73% Impervious = 0.792 ac

Summary for Subcatchment 2S: AREA TO BASIN 1

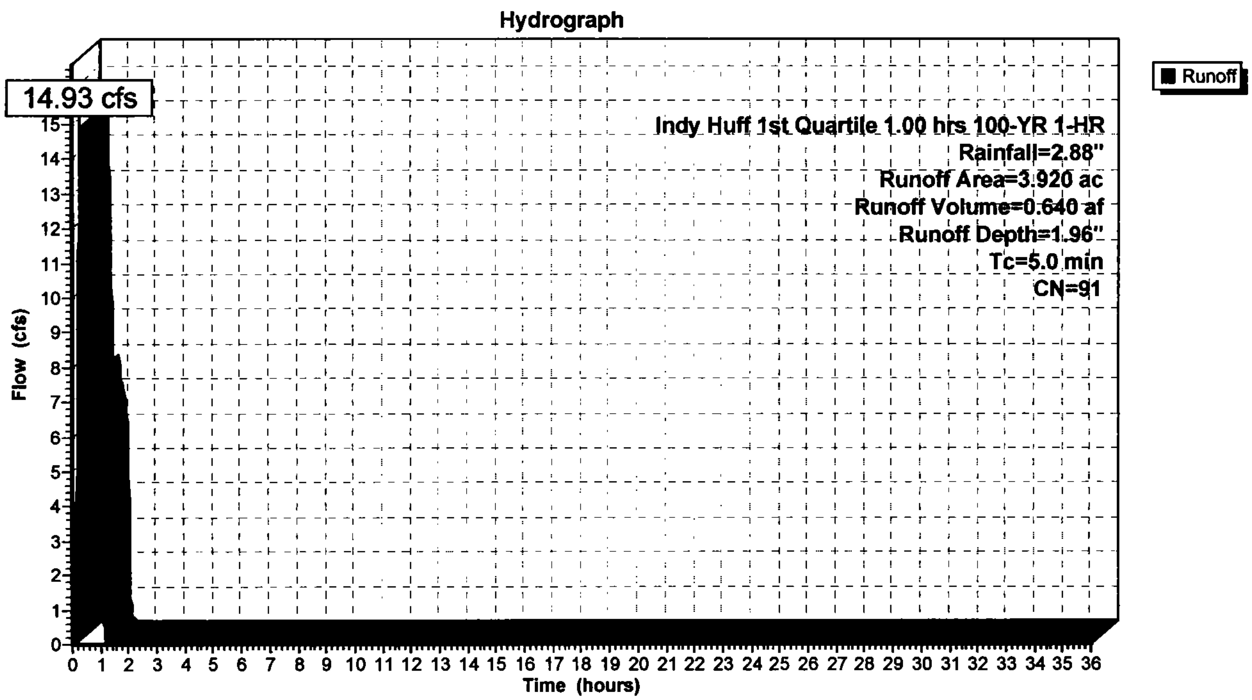
Runoff = 14.93 cfs @ 0.30 hrs, Volume= 0.640 af, Depth= 1.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 100-YR 1-HR Rainfall=2.88"

	Area (ac)	CN	Description
	0.737	98	Paved parking & roofs
	2.629	91	Gravel roads, HSG D
*	0.554	84	50-75% Grass Cover, Fair, HSG D
	3.920	91	Weighted Average
	3.183		Pervious Area
	0.737		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 2S: AREA TO BASIN 1



Summary for Subcatchment 3S: AREA TO BASIN 2

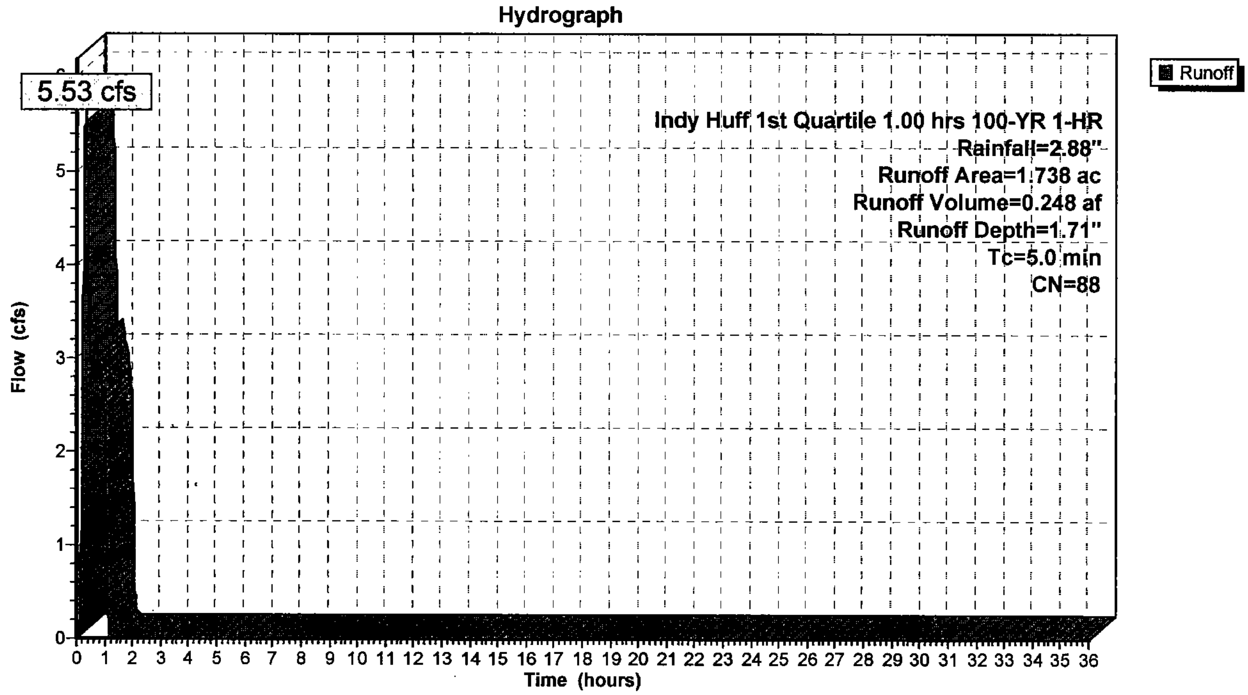
Runoff = 5.53 cfs @ 0.32 hrs, Volume= 0.248 af, Depth= 1.71"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 100-YR 1-HR Rainfall=2.88"

Area (ac)	CN	Description
0.055	98	Paved parking & roofs
0.888	84	50-75% Grass cover, Fair, HSG D
0.795	91	Gravel roads, HSG D
1.738	88	Weighted Average
1.683		Pervious Area
0.055		Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 3S: AREA TO BASIN 2



Summary for Subcatchment 4S: UNMANAGED AREA

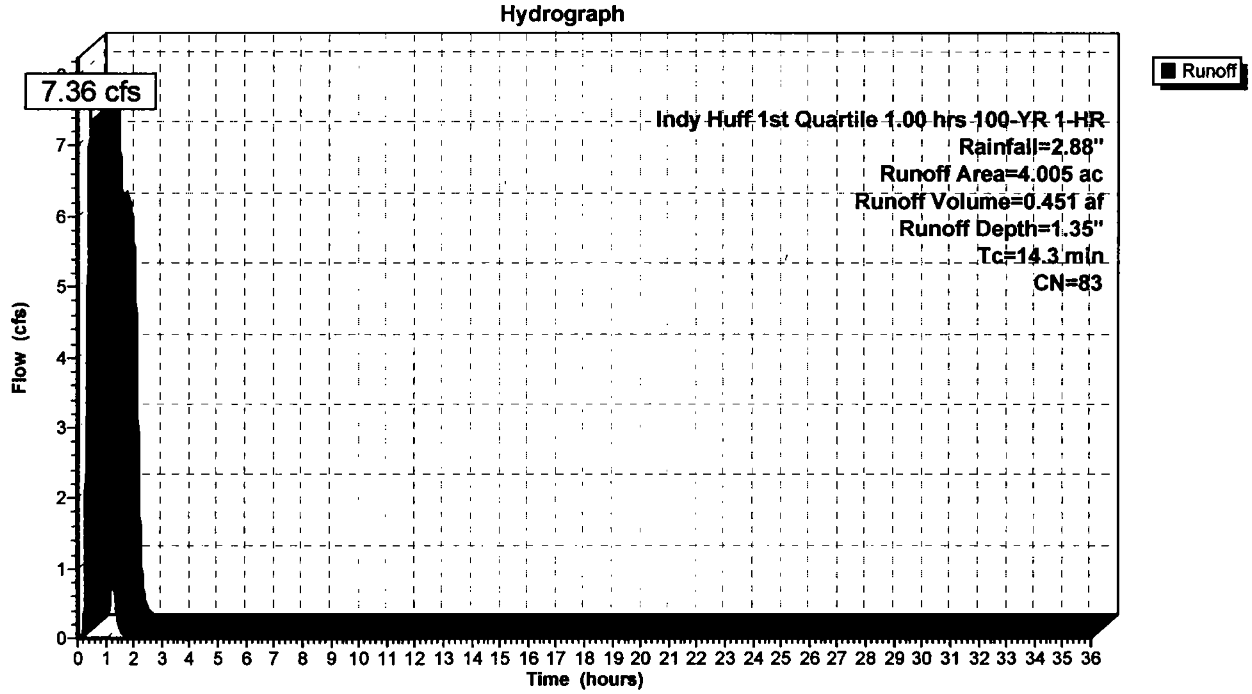
Runoff = 7.36 cfs @ 0.49 hrs, Volume= 0.451 af, Depth= 1.35"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 100-YR 1-HR Rainfall=2.88"

Area (ac)	CN	Description
2.819	84	50-75% Grass cover, Fair, HSG D
0.300	91	Gravel roads, HSG D
0.886	77	Woods, Good, HSG D
4.005	83	Weighted Average
4.005		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
14.3					**Direct Entry,**

Subcatchment 4S: UNMANAGED AREA



Summary for Subcatchment 9S: AREA TO BASIN 2

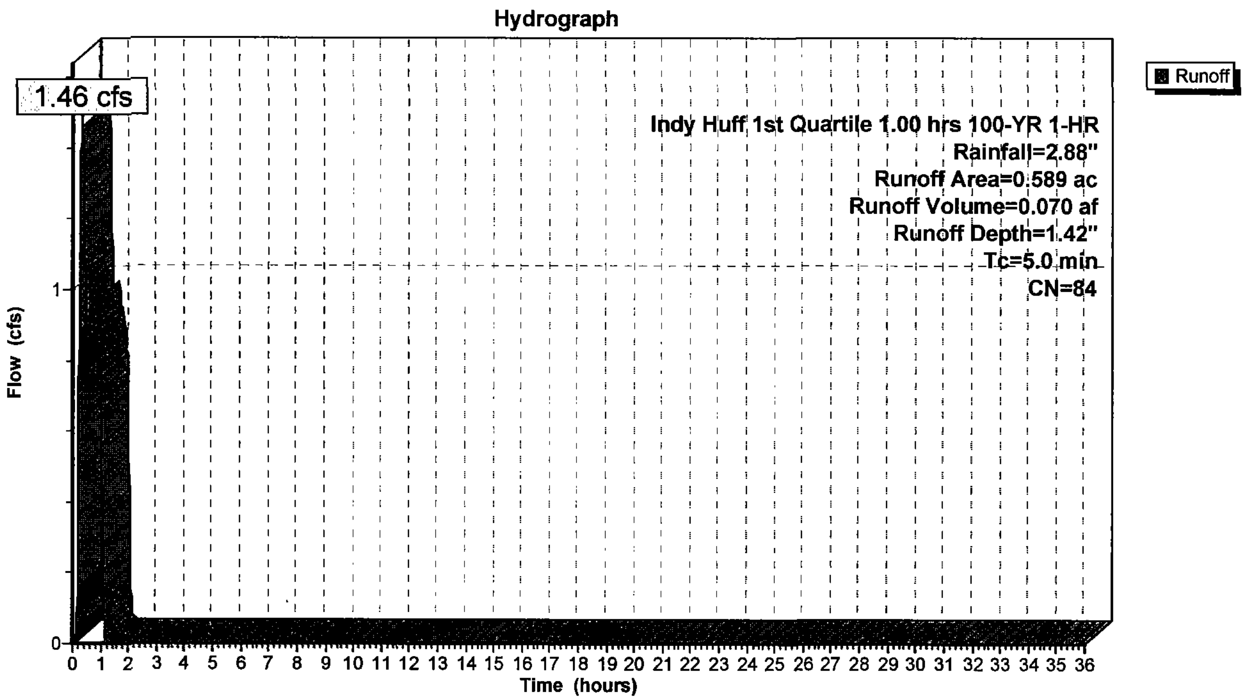
Runoff = 1.46 cfs @ 0.34 hrs, Volume= 0.070 af, Depth= 1.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Indy Huff 1st Quartile 1.00 hrs 100-YR 1-HR Rainfall=2.88"

	Area (ac)	CN	Description
*	0.550	84	50-75% Grass Cover, Fair, HSG D
*	0.039	91	Gravel
	0.589	84	Weighted Average
	0.589		Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry,**

Subcatchment 9S: AREA TO BASIN 2



Summary for Pond 5P: BASIN 1

Inflow Area = 3.920 ac, 18.80% Impervious, Inflow Depth = 1.96" for 100-YR 1-HR event
Inflow = 14.93 cfs @ 0.30 hrs, Volume= 0.640 af
Outflow = 6.32 cfs @ 0.93 hrs, Volume= 0.641 af, Atten= 58%, Lag= 37.6 min
Primary = 6.32 cfs @ 0.93 hrs, Volume= 0.641 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.95' @ 0.93 hrs Surf.Area= 17,759 sf Storage= 9,839 cf

Plug-Flow detention time= 20.5 min calculated for 0.640 af (100% of inflow)
Center-of-Mass det. time= 20.5 min (53.8 - 33.3)

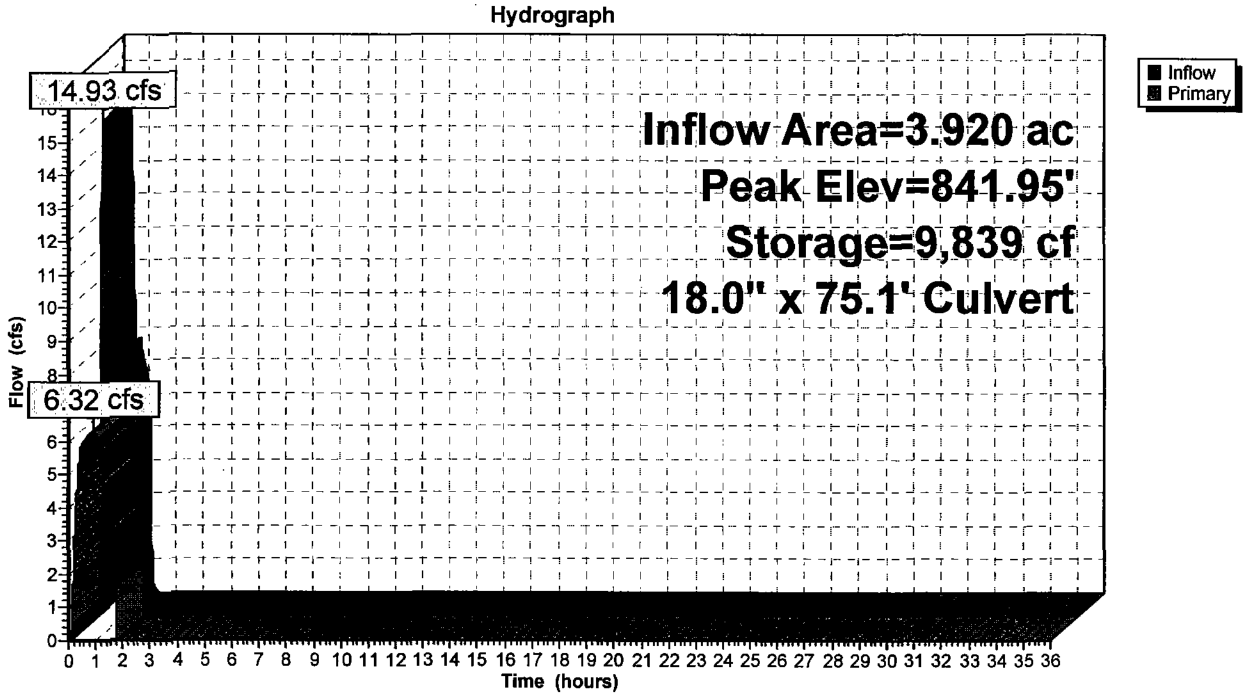
Volume	Invert	Avail.Storage	Storage Description
#1	841.00'	93,677 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
841.00	2,922	0	0
842.00	18,515	10,719	10,719
843.00	42,406	30,461	41,179
844.00	62,589	52,498	93,677

Device	Routing	Invert	Outlet Devices
#1	Primary	840.30'	**18.0" x 75.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.00' S= 0.0040 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=6.32 cfs @ 0.93 hrs HW=841.95' TW=840.52' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 6.32 cfs @ 4.05 fps)

Pond 5P: BASIN 1



Summary for Pond 6P: POCKET WETLAND

Inflow Area =	1.738 ac,	3.16% Impervious,	Inflow Depth = 1.71"	for 100-YR 1-HR event	
Inflow =	5.53 cfs @	0.32 hrs,	Volume=	0.248 af	
Outflow =	1.03 cfs @	1.08 hrs,	Volume=	0.243 af,	Atten= 81%, Lag= 45.5 min
Primary =	1.03 cfs @	1.08 hrs,	Volume=	0.243 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 841.50' @ 1.08 hrs Surf.Area= 10,924 sf Storage= 8,536 cf

Plug-Flow detention time= 161.8 min calculated for 0.243 af (98% of inflow)
Center-of-Mass det. time= 161.8 min (196.3 - 34.5)

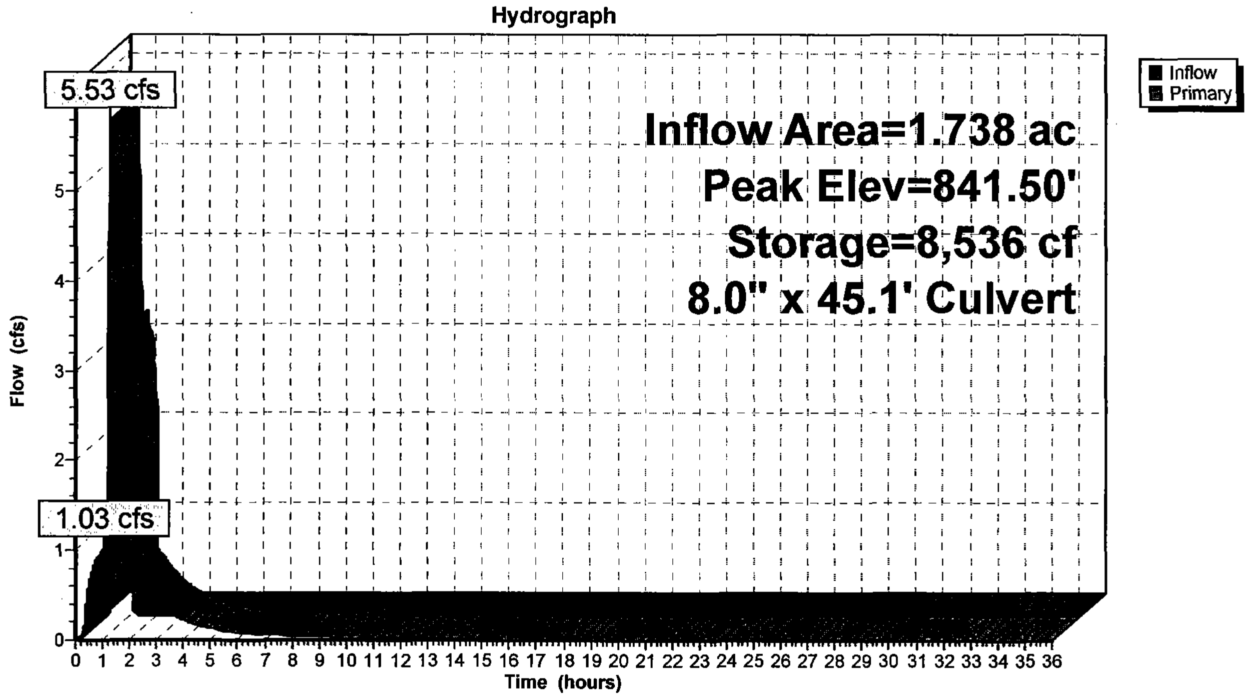
Volume	Invert	Avail.Storage	Storage Description
#1	840.50'	36,708 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
840.50	7,342	0	0
841.00	7,963	3,826	3,826
842.00	13,900	10,932	14,758
843.00	30,000	21,950	36,708

Device	Routing	Invert	Outlet Devices
#1	Primary	840.50'	**8.0" x 45.1' long Culvert** CPP, projecting, no headwall, Ke= 0.900 Outlet Invert= 840.30' S= 0.0044 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=1.03 cfs @ 1.08 hrs HW=841.50' TW=840.67' (Dynamic Tailwater)
1=Culvert (Barrel Controls 1.03 cfs @ 2.94 fps)

Pond 6P: POCKET WETLAND



Summary for Pond 7P: BASIN 2

Inflow Area =	6.247 ac,	12.68% Impervious,	Inflow Depth > 1.83"	for 100-YR 1-HR event
Inflow =	8.12 cfs @	0.89 hrs, Volume=	0.953 af	
Outflow =	6.37 cfs @	1.21 hrs, Volume=	0.953 af,	Atten= 22%, Lag= 19.4 min
Primary =	6.37 cfs @	1.21 hrs, Volume=	0.953 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 840.71' @ 1.21 hrs Surf.Area= 7,198 sf Storage= 11,731 cf

Plug-Flow detention time= 32.0 min calculated for 0.953 af (100% of inflow)
Center-of-Mass det. time= 31.8 min (120.6 - 88.9)

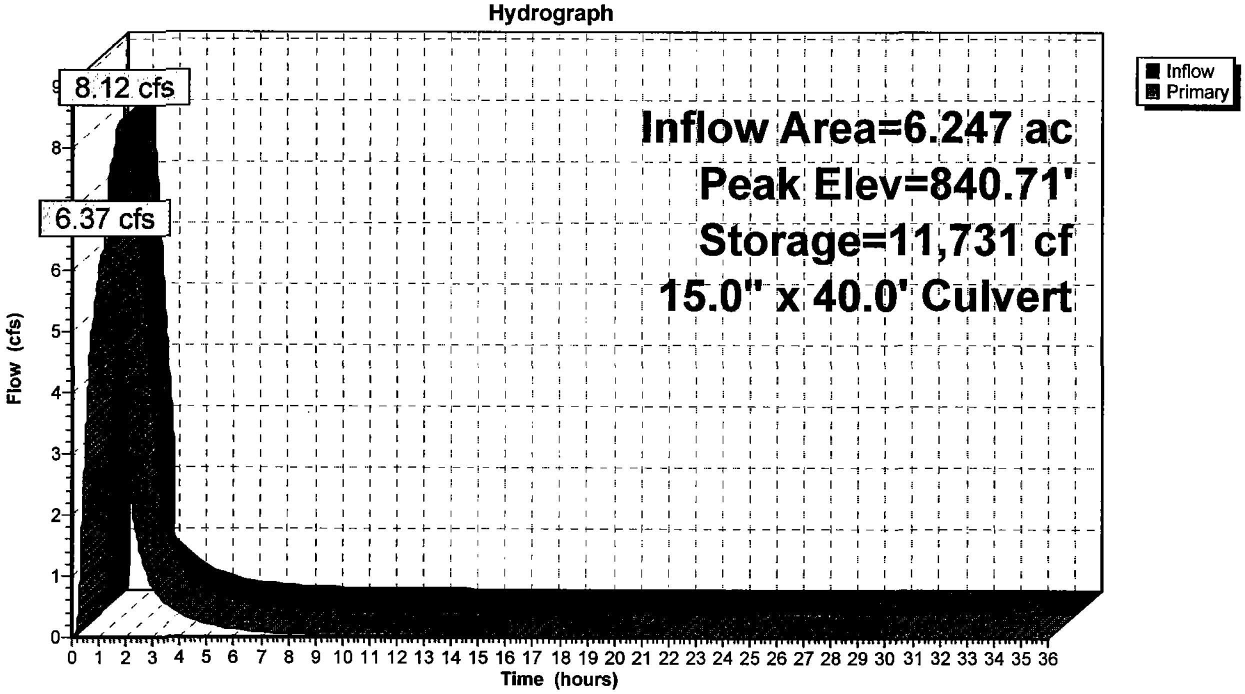
Volume	Invert	Avail.Storage	Storage Description
#1	838.70'	26,266 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
838.70	0	0	0
839.00	5,568	835	835
840.00	6,496	6,032	6,867
841.00	7,484	6,990	13,857
842.00	8,531	8,008	21,865
842.50	9,076	4,402	26,266

Device	Routing	Invert	Outlet Devices
#1	Primary	838.70'	**15.0" x 40.0' long Culvert** RCP, sq.cut end projecting, Ke= 0.500 Outlet Invert= 838.50' S= 0.0050 '/' Cc= 0.900 n= 0.012

Primary OutFlow Max=6.37 cfs @ 1.21 hrs HW=840.71' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 6.37 cfs @ 5.19 fps)

Pond 7P: BASIN 2

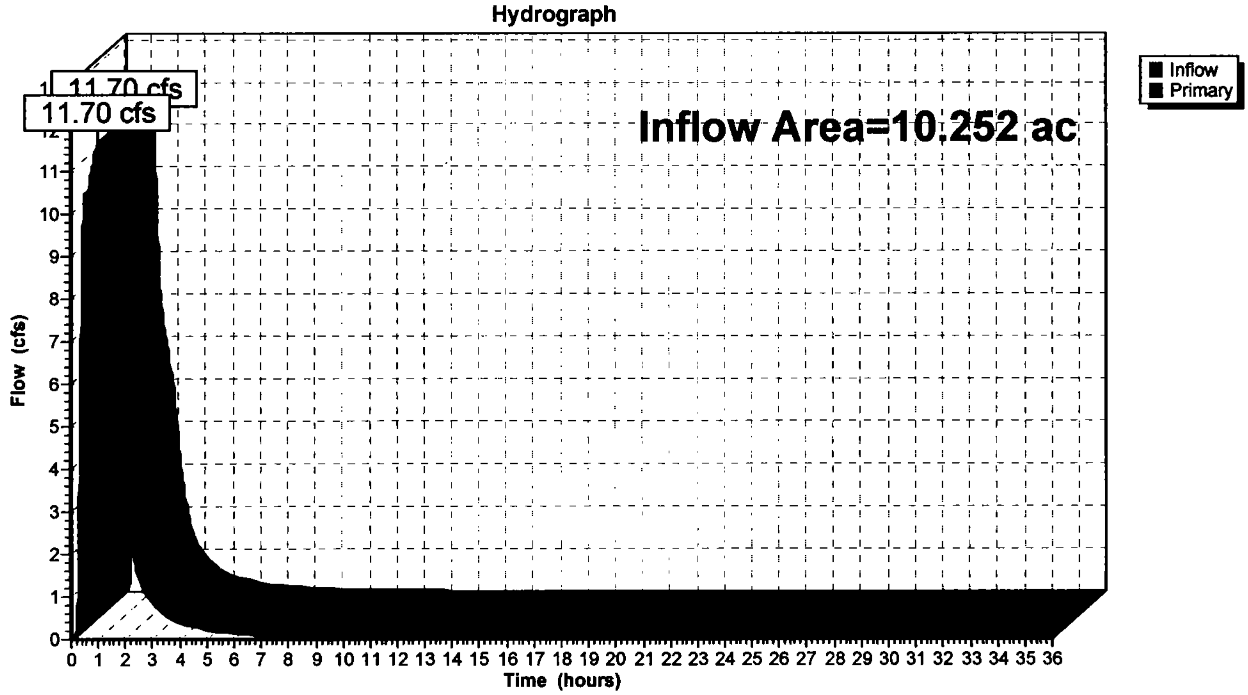


Summary for Link 8L: TOTAL POSTDEVELOPED

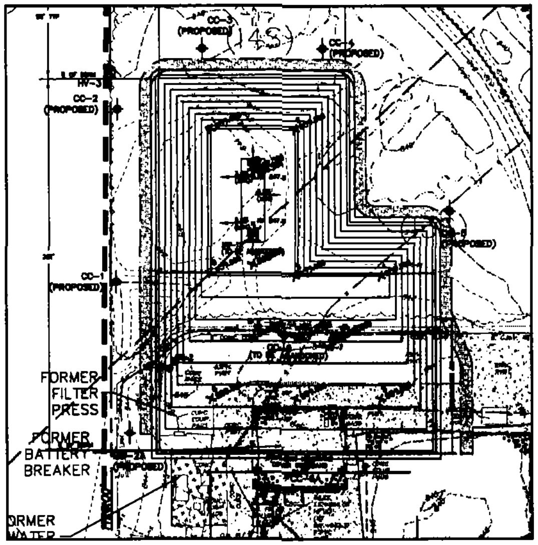
Inflow Area =	10.252 ac,	7.73% Impervious, Inflow Depth > 1.64"	for 100-YR 1-HR event
Inflow =	11.70 cfs @	1.00 hrs, Volume=	1.404 af
Primary =	11.70 cfs @	1.00 hrs, Volume=	1.404 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Link 8L: TOTAL POSTDEVELOPED



AMMENDED CMD DRAWINGS



TOP OF CAP (MINIMUM SLOPE)

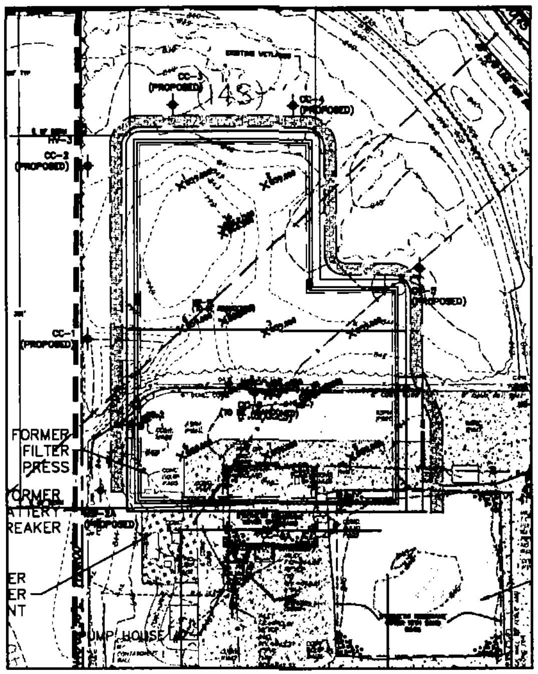
1" = 80'

CONTAINMENT CELL WASTE CAPACITY					
MINIMUM WITH CCB EXTENSION					
ELEVATION	AREA (SF)	DIFF DEPTH (FT)	VOL (CF)	CUM. VOL (CF)	CUM. VOL (CY)
841.5	79,744				
		0.5	40,808	40,808	1,511
842	83,490				
		2	162,165	202,973	7,518
844	78,675				
		2	150,081	353,054	13,076
846	71,406				
		2	131,462	484,516	17,945
848	60,056				
		2	109,494	594,010	22,000
850	49,438				
		2	88,992	683,002	25,296
852	39,554				
		2	69,956	752,958	27,887
854	30,402				
		2	52,296	805,254	29,824
856	21,894				
		2	38,596	843,850	31,254
858	16,702				
		1	14,500	858,350	31,828
859	14,298				
		1	9,172	867,522	32,130
860	2,046				
		0.5	512	868,033	32,149
860.5	0				

Minumum Grading Capacity	32,149
Previously Placed Waste	21,480
CCB Minimum Volume (Approx.)	10,669

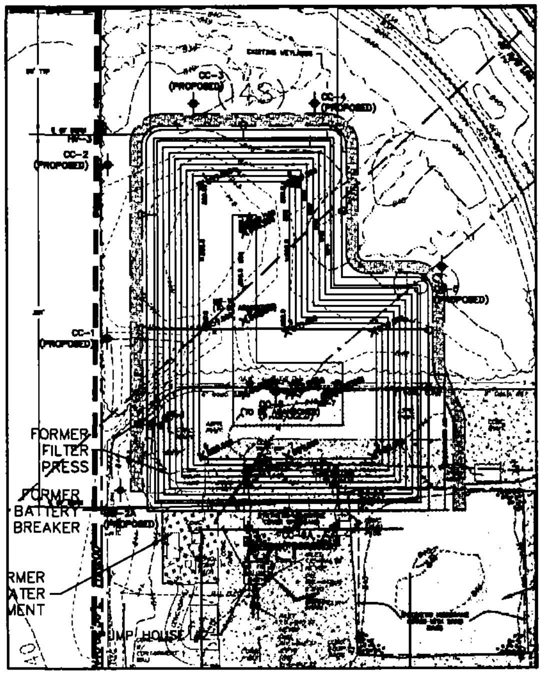
CONTAINMENT CELL WASTE CAPACITY					
MAXIMUM WITH CCB EXTENSION					
ELEVATION	AREA (SF)	DIFF DEPTH (FT)	VOL (CF)	CUM. VOL (CF)	CUM. VOL (CY)
841.5	79,744				
		0.5	22,236	22,236	824
842	9,200				
		2	92,691	114,927	4,257
844	83,491				
		2	159,559	274,486	10,166
846	76,068				
		2	145,002	419,488	15,537
848	68,934				
		2	131,023	550,511	20,389
850	62,089				
		2	117,620	668,131	24,746
852	55,531				
		2	104,792	772,923	28,627
854	49,261				
		2	92,541	865,464	32,054
856	43,280				
		2	80,866	946,330	35,049
858	37,586				
		1	36,217	982,546	36,391
859	34,847				
		1	22,805	1,005,351	37,235
860	10,762				
		0.5	2,691	1,008,041	37,335
860.5	0				

Minumum Grading Capacity	37,335
Previously Placed Waste	21,480
CCB Maximum Volume (Approx.)	15,855



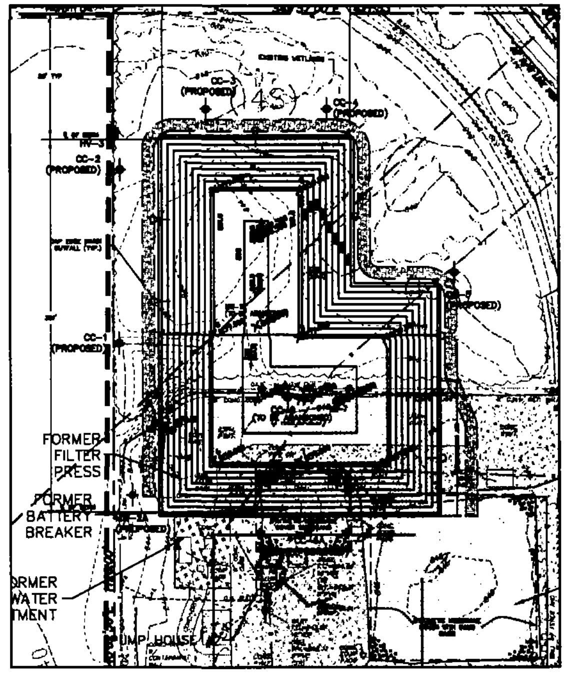
BASE GRADING

1" = 80'



TOP OF WASTE (MAXIMUM SLOPE)

1" = 80'



TOP OF CAP (MAXIMUM SLOPE)

1" = 80'

DATE	REVISION
9-14-10	REPLACED BASE MAP AND RESPONSE TO COMMENTS
10-8-10	REVISED TO FINAL DESIGN
3-[illegible]-11	REVISE GW WELL LOCATIONS
11-7-12	REVISE WETLAND LIMIT AND PROPOSED GRADING
8-19-14	REVISED PER EPA REVIEW LETTER
6-13-18	EXPANDED CCB GRADING AND REVISED TABLE

LEGEND

- Existing Contour
- Existing Building
- Former Building Footprint
- Existing Edge of Paving
- Existing Right of Way
- Existing Tree Line
- Existing Wetland Limit Line
- Existing Flood Plain Limit Line
- Existing Lot Line
- Property Line (Approximate)
- Existing Sanitary Sewer
- Existing Stormwater Line w/ Inlet
- Existing Water Line
- Existing Gas Line
- Existing Electric Line
- Existing Utility Pole
- Existing Fence Line
- MW-11 Monitoring Well
- CC-1 (PROPOSED) Containment Cell Groundwater Monitoring Well (To be installed prior to start of CM construction by RMC)

NOTES:

1. TOPOGRAPHIC SURVEY WITHIN REFINED METALS PROPERTY OBTAINED FROM FIELD SURVEY PERFORMED BY THE SCHNEIDER CORPORATION AUGUST, 2010. ORIGINATING BENCHMARK INDIANA DEPARTMENT OF TRANSPORTATION BRONZE DISC STAMPED "MAR 0-384" ELEVATION 862.40 (NGVD 29).

2. TOPOGRAPHIC INFORMATION OUTSIDE OF REFINED METALS PROPERTY OBTAINED FROM IMAGIS CITY OF INDIANAPOLIS BASED ON NGVD 29.

3. BUILDINGS ON THE REFINED METALS PROPERTY HAVE BEEN DEMOLISHED, EXCEPT PUMP HOUSES #1 THROUGH #4.

4. CONTRACTORS SURVEYOR MUST FIELD LOCATE RMC PROPERTY LINE AND PERFORM FIELD STAKEOUT RELATIVE TO PROPERTY LINE.

ADVANCED GeoServices

Engineering for the Environment. Planning for People™

REFINED METALS CORPORATION
BEECH GROVE, INDIANA

CORRECTIVE MEASURES DESIGN
FINAL DESIGN
AMMENDED

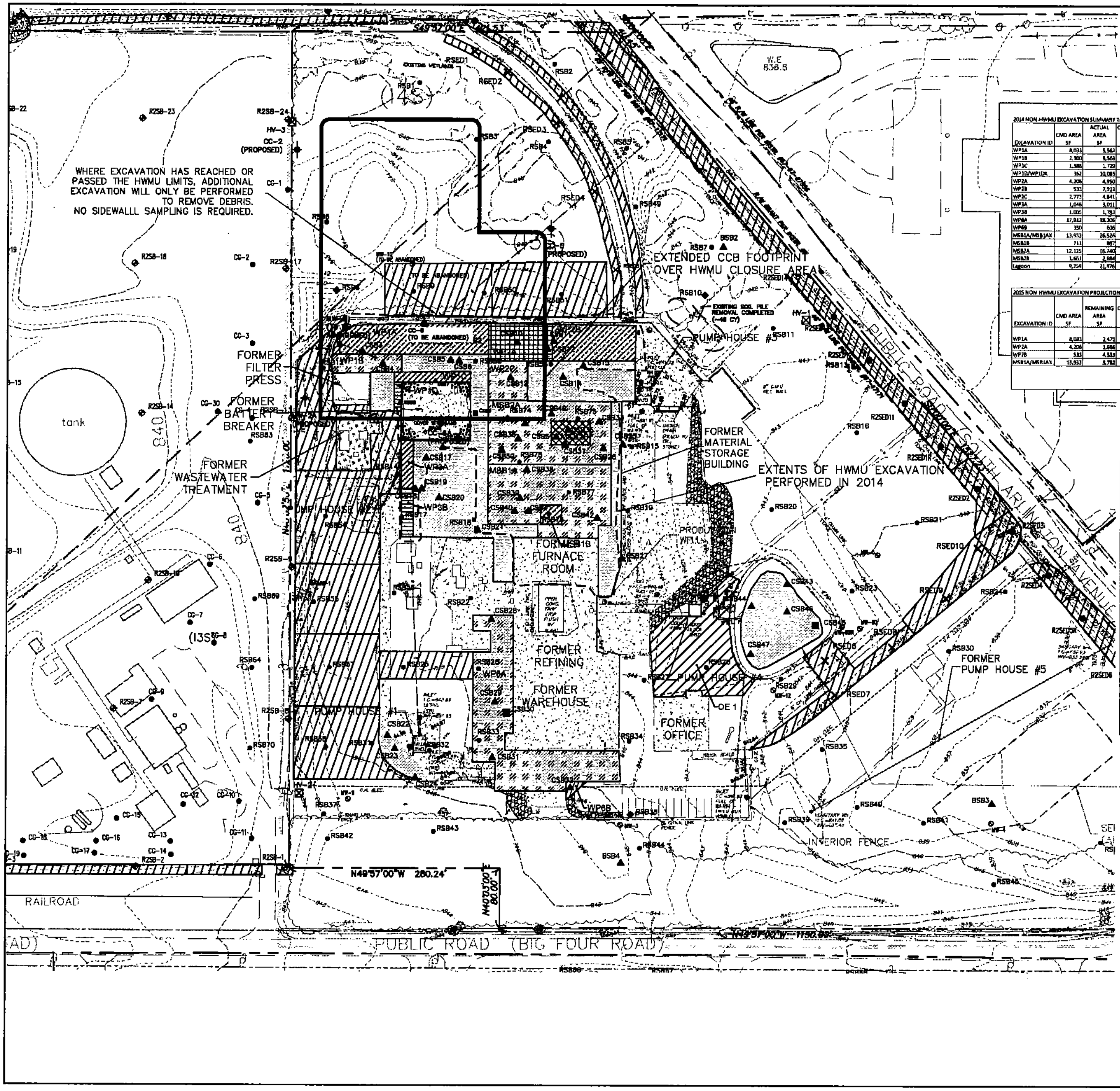
CONTAINMENT CELL CONSTRUCTION, FILLING AND CAPPING PLAN

5A

Scale	1"=80'
Designed by	J.W.D.
Drawn by	P.S.G.
Checked by	J.W.D.
Approved by	P.G.S.
Project No.	2003-1046
Sheet No.	8 OF 12

GRAPHIC SCALE

(IN FEET)
1 inch = 80 ft.



2014 NON-HWMU EXCAVATION SUMMARY TABLE

EXCAVATION ID	CMD AREA SF	ACTUAL AREA SF	CMD REMOVAL DEPTH FT	ACTUAL REMOVAL DEPTH (AVG.) FT	CMD EXCAVATION VOLUME CY	2014 EXCAVATED VOLUME CY	EXCAVATION COMPLETE
WP1A	8,033	5,563	2.5	3.5	744	714	NO
WP1B	2,300	5,563	1.0	4.3	85	894	YES
WP1C	1,388	1,729	1.3	4.5	67	291	YES
WP1D/WP1DX	362	10,086	3.3	5.1	44	1,902	YES
WP2A	4,206	4,950	7.3	6.6	1,137	1,210	NO
WP2B	533	7,912	2.5	5.0	49	1,463	NO
WP2C	2,773	4,841	1.0	3.7	103	657	YES
WP3A	1,046	3,011	1.3	2.5	50	282	YES
WP3B	1,005	1,783	3.3	3.5	123	230	YES
WP6A	17,912	18,306	1.0	1.9	663	1,299	YES
WP6B	350	606	1.3	1.6	17	37	YES
MSB1A/MSB1AX	13,933	26,526	1.0	2.3	516	2,230	NO
MSB1B	711	887	2.5	3.5	66	116	YES
MSB2A	12,125	16,740	1.0	3.3	449	2,016	YES
MSB2B	1,661	2,684	6.0	5.5	369	547	YES
Lagoon	9,259	21,976	1.0	1.5	343	1,243	YES
					4,826	15,131	

2015 NON HWMU EXCAVATION PROJECTIONS

EXCAVATION ID	CMD AREA SF	REMAINING AREA SF	CMD REMOVAL DEPTH FT	PROJECTED REMOVAL DEPTH FT	CMD EXCAVATION VOLUME CY	2015 PROJECTED VOLUME CY
WP1A	8,033	2,471	2.5	4.5	744	412
WP2A	4,206	1,666	7.3	7.3	1,137	450
WP2B	533	4,533	2.5	5.5	49	923
MSB1A/MSB1AX	13,933	3,782	1.0	4.0	516	580
					PROJECTED 2015 HWMU EXCAVATION VOLUME =	2,346
					ADDITIONAL CONCRETE REMOVAL =	450
						2,796

EXCAVATION SUMMARY TABLE				XRF SCREENING & LAB ANALYZED	
EXCAVATION I.D.	AREA (sf)	REMOVAL DEPTH (ft)	REMOVAL VOLUME (cf)	# OF CONFIRMATION SAMPLES REQUIRED	# OF SIDEWALL SAMPLES REQUIRED
WP1A	8033.07	2.5	20067.63	5	10
WP1B	2300.40	1.0	2301.40	3	2
WP1C	1358.50	1.3	1805.09	3	6
WP1D	362.58	3.3	1195.45	3	2
WP2A	4206.60	7.3	30708.12	3	9
WP2B	5356.01	2.5	13342.03	3	5
WP2C	2773.56	1.0	2773.55	3	4
WP3A	1046.31	1.3	1360.46	3	3
WP3B	1005.24	3.3	3317.29	3	4
WP6A	17912.19	1.0	17912.19	10	0
WP6B	350.71	1.3	455.92	3	1
MSB1A	13933.45	1.0	13933.45	10	15
MSB1B	711.21	2.5	1778.03	3	3
MSB2A	12124.90	1.0	12124.90	10	15
MSB2B	1661.31	6.0	9967.86	3	6
LAGOON	9259	1.0	9259	5	18

LAGOON: REMOVE ACCUMULATED WATER FOR TREATMENT AND MANAGEMENT THROUGH TEMPORARY TREATMENT SYSTEM, REMOVE VEGETATION, SEDIMENT AND GEOMEMBRANE AND DISPOSE IN CONTAINMENT CELL. PRESSURE WASH CONCRETE SURFACE. DEMOLISH CONCRETE AND SEGREGATE FOR POSSIBLE CRUSHING AND REUSE. PERFORM CONFIRMATORY SAMPLING OF REMAINING SOIL.

DATE	REVISION
8-14-10	REPLACED BASE MAP AND RESPONSE TO COMMENTS
10-8-10	REVISED TO FINAL DESIGN
3-21-11	REVISE CC WELL LOCATIONS
11-7-12	REVISE WETLAND LIMIT
2-10-14	REVISED PER EPA REVIEW LETTER
5-1-13	REVISE TABLE
5-10-15	[illegible]

LEGEND

- Existing Contour
- Existing Building
- Former Building Footprint
- Existing Edge of Paving
- Existing Right of Way
- Existing Tree Line
- Existing Wetland Limit Line
- Existing Flood Plain Limit Line
- Existing Lot Line
- Property Line (Approximate)
- Existing Sanitary Sewer
- Existing Stormwater Line w/ Inlet
- Existing Water Line
- Existing Gas Line
- Existing Electric Line
- Existing Utility Pole
- RCRA HWMU That does not Require Soil Removal
- 12" Removal Depth
- 15" Removal Depth
- 30" Removal Depth
- 39" Removal Depth
- 72" Removal Depth
- 87" Removal Depth
- MW-11 Monitoring Well
- Approximate Soil Sample Location
- Soil Sample Location/Designation Surveyed by the Schneider Corp., Indianapolis, Indiana
- Soil Sample Location/Designation Surveyed by the Schneider Corp., Indianapolis, Indiana
- Phase II RFI Soil Sampling
- Sediment Sample Location S. Arlington Ave. Drainage Ditch
- Sediment Sample Location S. Arlington Ave. Drainage Ditch
- Sediment Sample Location in Grassy Area Swales
- CC-1 (PROPOSED) Containment Cell Groundwater Monitoring Well (To be installed prior to start of CM construction by RMC)

NOTES:

1. TOPOGRAPHIC SURVEY WITHIN REFINED METALS PROPERTY OBTAINED FROM FIELD SURVEY PERFORMED BY THE SCHNEIDER CORPORATION AUGUST, 2010. ORIGINATING BENCHMARK INDIANA DEPARTMENT OF TRANSPORTATION BRONZE DISC STAMPED "MAR C-354" ELEVATION 882.49 (NGVD 29).
2. TOPOGRAPHIC INFORMATION OUTSIDE OF REFINED METALS PROPERTY OBTAINED FROM IMAGIS CITY OF INDIANAPOLIS BASED ON NGVD 29.
3. BUILDINGS ON THE REFINED METALS PROPERTY HAVE BEEN DEMOLISHED, EXCEPT PUMP HOUSES #1 THROUGH #4.
4. SOIL REMOVAL DEPTHS MEASURED FROM TOP OF ORIGINAL GROUND SURFACE.

ADVANCED GeoServices

Engineering for the Environment. Planning for People.™

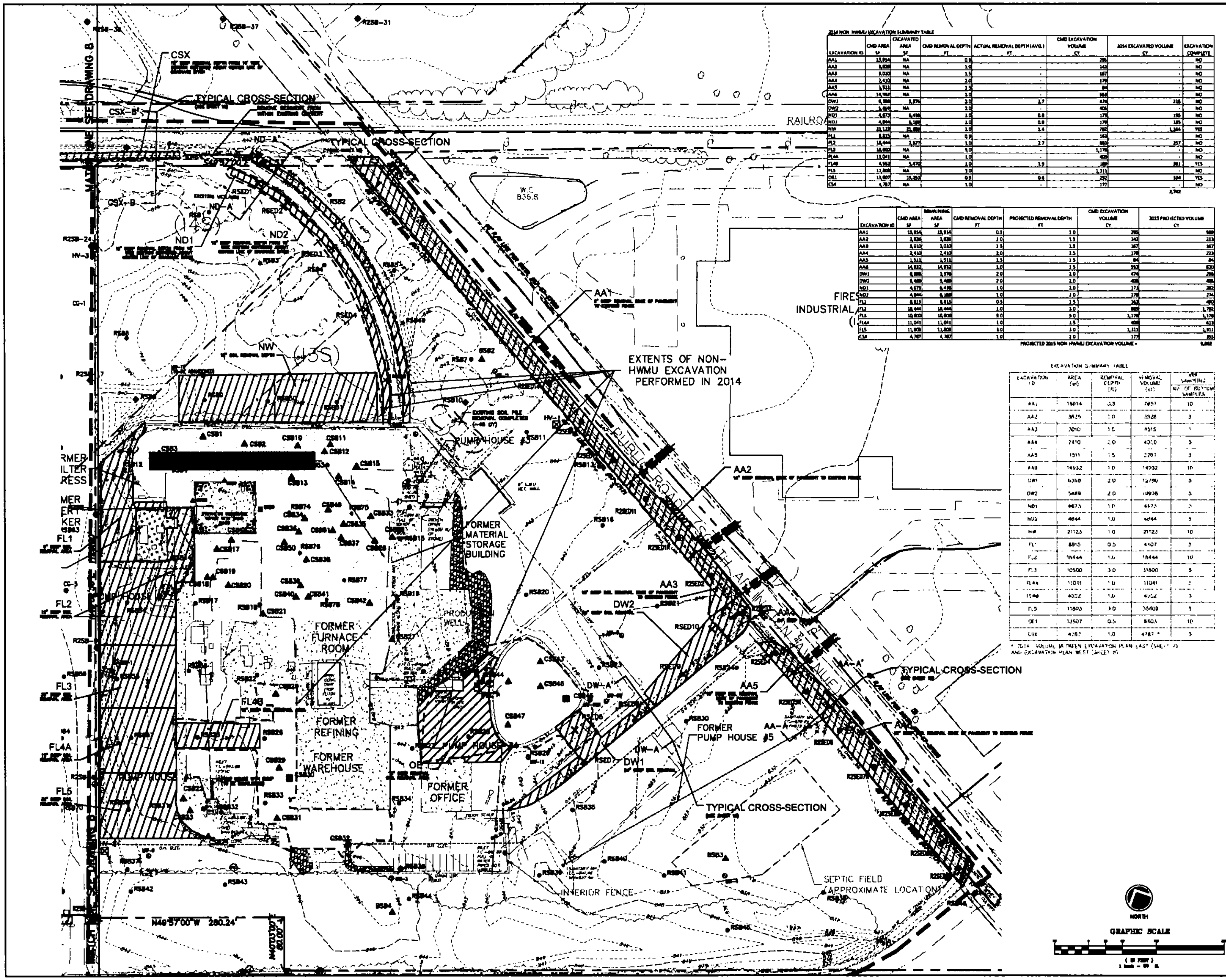
REFINED METALS CORPORATION
BEECH GROVE, INDIANA

CORRECTIVE MEASURES DESIGN
FINAL DESIGN
AMMENDED

HAZARDOUS WASTE MANAGEMENT
UNIT CLOSURE PLAN

6A

Scale	1"=50'
	J.W.D.
	P.S.C.
	J.W.D.
	P.G.S.
	2003-1046
	6 OF 12



2014 NON-HWMU EXCAVATION SUMMARY TABLE

EXCAVATION ID	CMD AREA SF	EXCAVATED AREA SF	CMD REMOVAL DEPTH FT	ACTUAL REMOVAL DEPTH (AVG.) FT	CMD EXCAVATION VOLUME CY	2014 EXCAVATED VOLUME CY	EXCAVATION COMPLETE
AA1	13,914	NA	0.5		[illegible]	-	NO
AA2	3,826	NA	1.0	-	142	-	NO
AA3	3,010	NA	1.5	-	167	-	NO
AA4	2,410	NA	2.0	-	179	-	NO
AA5	1,511	NA	1.5	-	84	-	NO
AA6	14,932	NA	1.0	-	553	-	NO
DW1	6,380	3,376	2.0	1.7	474	218	NO
DW2	5,469	NA	2.0	-	405	-	NO
ND1	4,673	6,430	1.0	0.8	173	193	NO
ND2	4,844	6,189	1.0	0.9	179	185	NO
NW	21,123	[illegible]	1.0	1.4	782	1,164	YES
FL1	8,815	NA	0.5	-	163		NO
FL2	18,444	3,577	1.0	2.7	683	357	NO
FL3	10,600	NA	3.0	-	1,178	-	NO
FL4A	11,041	NA	1.0	-	409	-	NO
FL4B	4,552	5,470	1.0	1.9	169	381	YES
FL5	11,808	NA	3.0	-	1,311	-	NO
OE1	13,607	15,253	0.5	0.6	252	334	YES
CSX	4,787	NA	1.0	-	177	-	NO
						2,742	

EXCAVATION ID	CMD AREA SF	REMAINING AREA SF	CMD REMOVAL DEPTH FT	PROJECTED REMOVAL DEPTH FT	CMD EXCAVATION VOLUME CY	2015 PROJECTED VOLUME CY
AA1	13,914	13,914	0.5	1.0	[illegible]	[illegible]
AA2	3,826	3,826	1.0	1.5	142	213
AA3	3,010	3,010	1.5	1.5	167	167
AA4	2,410	2,410	2.0	2.5	179	223
AA5	1,511	1,511	1.5	1.5	84	84
AA6	14,932	14,932	1.0	1.5	553	830
DW1	6,380	3,376	2.0	2.0	474	[illegible]
DW2	5,469	5,469	2.0	2.0	405	405
ND1	4,673	6,430	1.0	2.0	173	[illegible]
ND2	4,844	6,189	1.0	1.0	179	[illegible]
FL1	8,815	8,815	0.5	1.5	163	490
FL2	18,444	18,444	1.0	2.0	683	[illegible]
FL3	10,600	10,600	3.0	3.0	1,178	1,178
FL4A	11,041	11,041	1.0	1.5	409	613
FL5	11,808	11,808	3.0	3.0	1,311	1,311
CSX	4,787	4,787	1.0	2.0	177	355
				PROJECTED 2015 NON-HWMU EXCAVATION VOLUME =		[illegible]

EXCAVATION SUMMARY TABLE

EXCAVATION ID	AREA (sf)	REMOVAL DEPTH (ft)	REMOVAL VOLUME (cf)	RMI SAMPLING NO. OF BOTTOM SAMPLES
AA1	13914	0.5	7957	10
AA2	3826	1.0	3826	5
AA3	3010	1.5	4515	5
AA4	2410	2.0	4820	5
AA5	1511	1.5	2267	5
AA6	14932	1.0	14932	10
DW1	6380	2.0	12760	5
DW2	5469	2.0	10938	5
ND1	4673	1.0	4673	5
ND2	4844	1.0	4844	5
NW	21123	1.0	21123	10
FL1	8815	0.5	4407	5
FL2	18444	1.0	18444	10
FL3	10600	3.0	31800	5
FL4A	11041	1.0	11041	5
FL4B	4552	1.0	4552	5
FL5	11803	3.0	35409	5
OE1	13507	0.5	6753	10
CSX	4787	1.0	4787 *	5

* TOTAL VOLUME IN BOTH EXCAVATION PLAN EAST (SHEET 7) AND EXCAVATION PLAN WEST (SHEET 8)

NOTES:

1. TOPOGRAPHIC SURVEY WITHIN REFINED METALS PROPERTY OBTAINED FROM FIELD SURVEY PERFORMED BY THE SCHNEIDER CORPORATION AUGUST, 2010. ORIGINATING BENCHMARK INDIANA DEPARTMENT OF TRANSPORTATION BRONZE DISC STAMPED "MAR 6-364" ELEVATION 852.48 (NGVD 29).

2. TOPOGRAPHIC INFORMATION OUTSIDE OF REFINED METALS PROPERTY OBTAINED FROM IMAGIS CITY OF INDIANAPOLIS BASED ON NGVD 29.

3. BUILDINGS ON THE REFINED METALS PROPERTY HAVE BEEN DEMOLISHED, EXCEPT PUMP HOUSES #1 THROUGH #4.

ADVANCED GeoServices

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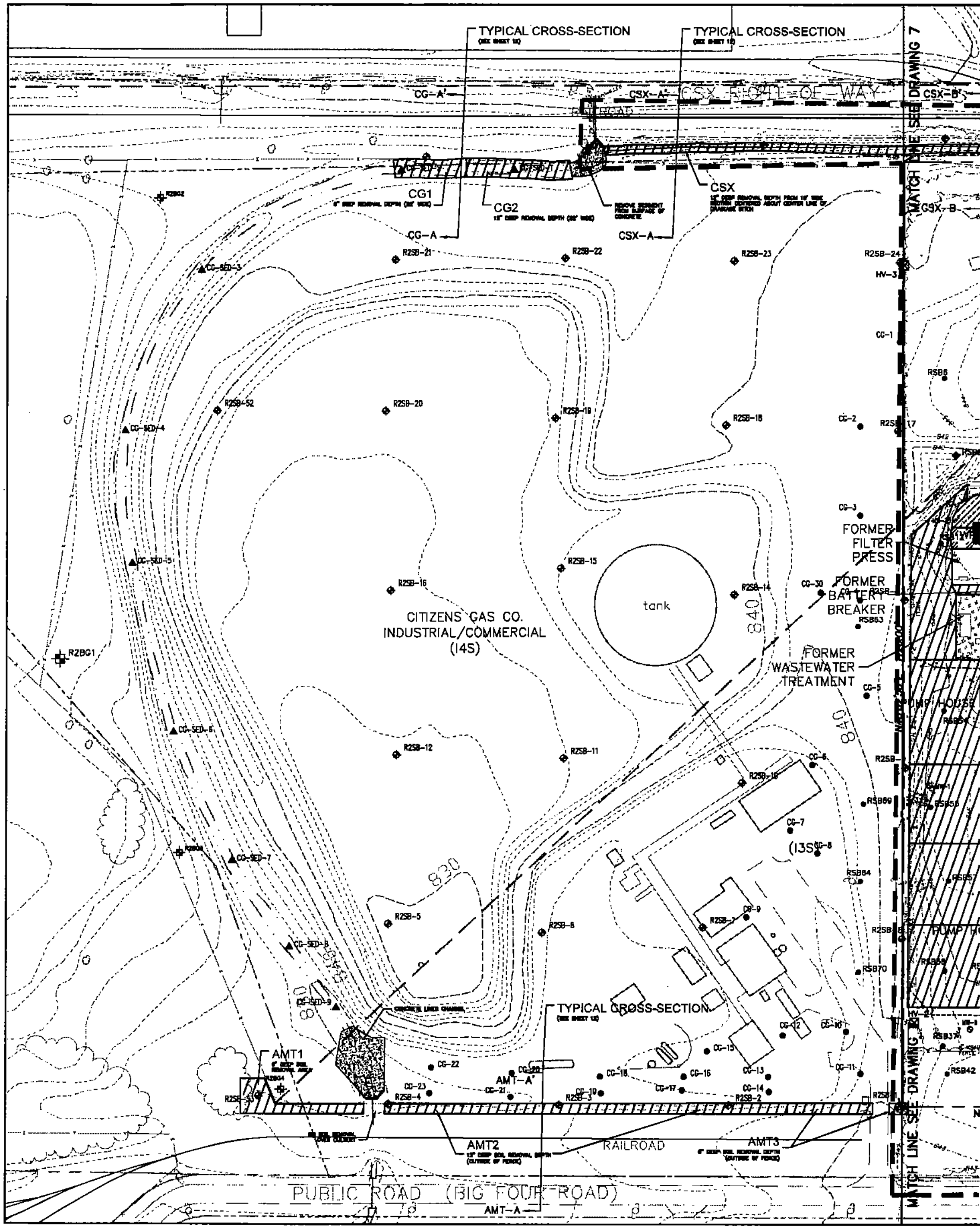
REFINED METALS CORPORATION
BEECH GROVE, INDIANA

CORRECTIVE MEASURES DESIGN
FINAL DESIGN
AMMENDED

SOIL AND SEDIMENT
EXCAVATION PLAN (EAST)

7A

	1"=60'
	J.W.D.
	P.S.S.
	J.W.D.
	P.S.S.
	2003-1046
	7 OF 12



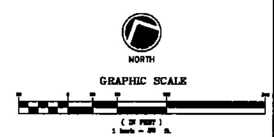
2014 OFFSITE EXCAVATION SUMMARY TABLE							
EXCAVATION ID	CMD AREA SF	ACTUAL AREA SF	CMD REMOVAL DEPTH FT	ACTUAL REMOVAL DEPTH (AVG.) FT	CMD EXCAVATION VOLUME CY	2014 EXCAVATED VOLUME CY	EXCAVATION COMPLETE
CSX	SEE SHEET 7						NO
CG1	1,871	1,871	0.5	-	35	-	NO
CG2	2,703	2,703	1.0	-	100	-	NO
AMT1	2,743	2,743	0.5	-	51	-	NO
AMT2	5,874	5,874	1.0	-	218	-	NO
AMT3	280	280	0.5	-	5	-	NO
					408	0	

2015 OFFSITE EXCAVATION PROJECTIONS						
EXCAVATION ID	CMD AREA SF	REMAINING AREA SF	CMD REMOVAL DEPTH FT	PROJECTED REMOVAL DEPTH FT	CMD EXCAVATION VOLUME CY	2015 PROJECTED VOLUME CY
CSX	SEE SHEET 7					
CG1	1,871	1,871	0.5	0.5	35	35
CG2	2,703	2,703	1.0	1.0	100	100
AMT1	2,743	2,743	0.5	0.5	51	51
AMT2	5,874	5,874	1.0	1.0	218	218
AMT3	280	280	0.5	0.5	5	5
PROJECTED 2015 OFFSITE EXCAVATION VOLUME =						374

NOTE: ADDITIONAL SOIL TO BE EXCAVATED ON CITIZENS GAS PROPERTY AS PART OF SEPARATE AGREEMENT

EXCAVATION SUMMARY TABLE

EXCAVATION I.D.	AREA (sf)	REMOVAL DEPTH (ft)	REMOVAL VOLUME (cf)	XRF SAMPLING No OF BOTTOM SAMPLED
CSX	SEE	SHEET 7	TABLE	–
CG1	1871.41	0.5	935.71	3
CG2	2703.61	1.0	2703.61	3
AMT1	2743.38	0.5	1371.68	3
AMT2	5874.38	1.0	5874.38	5
AMT3	279.54	0.5	139.77	3



DATE	REVISION
8-14-10	REPLACED BASE MAP AND RESPONSE TO COMMENTS
10-8-10	REVISED TO FINAL DESIGN
3-21-11	REVISED TO SHOW NUMBER OF CONFIRMATORY SAMPLES
11-7-12	REVISE WETLAND LIMIT
2-19-14	REVISED PER EPA REVIEW LETTER
8/18/2014	[illegible]
6-10-15	[illegible]

LEGEND

- Existing Contour
- Existing Building
- Former Building Footprint
- Existing Edge of Paving
- Existing Right of Way
- Existing Tree Line
- Existing Wetland Limit Line
- Existing Flood Plain Limit Line
- Existing Lot Line
- Property Line (Approximate)
- Existing Sanitary Sewer
- Existing Stormwater Line w/ Inlet
- Existing Water Line
- Existing Gas Line
- Existing Electric Line
- Existing Utility Pole
- Non-HWMU Excavation Area with Excavation Depth in Inches
- MW-11 Monitoring Well
- Approximate Soil Sample Location
- Soil Sample Location/Designation Surveyed by the Schneider Corp., Indianapolis, Indiana
- Soil Sample Location/Designation Surveyed by the Schneider Corp., Indianapolis, Indiana
- CG-7 Citizens Gas Soil Sample (Field Located) Oct 2008
- Phase II RFI Soil Sampling
- Sediment Sample Location S. Arlington Ave. Drainage Ditch
- Sediment Sample Location S. Arlington Ave. Drainage Ditch
- Sediment Sample Location in Grassy Area Swales

NOTES:

1. BASE MAP FROM HERITAGE ENVIRONMENTAL SERVICES, INC. DRAWING No. 2519OU22 DATED JULY 13, 1994. NO BENCHMARK PROVIDED ON REFERENCE DRAWING.

2. BUILDINGS ON THE REFINED METALS PROPERTY HAVE BEEN DEMOLISHED, EXCEPT PUMP HOUSES.

ADVANCED GeoServices

Engineering for the Environment. Planning for People.™

1055 ANDREW DRIVE, SUITE A
WEST CHESTER, PENNSYLVANIA 19380

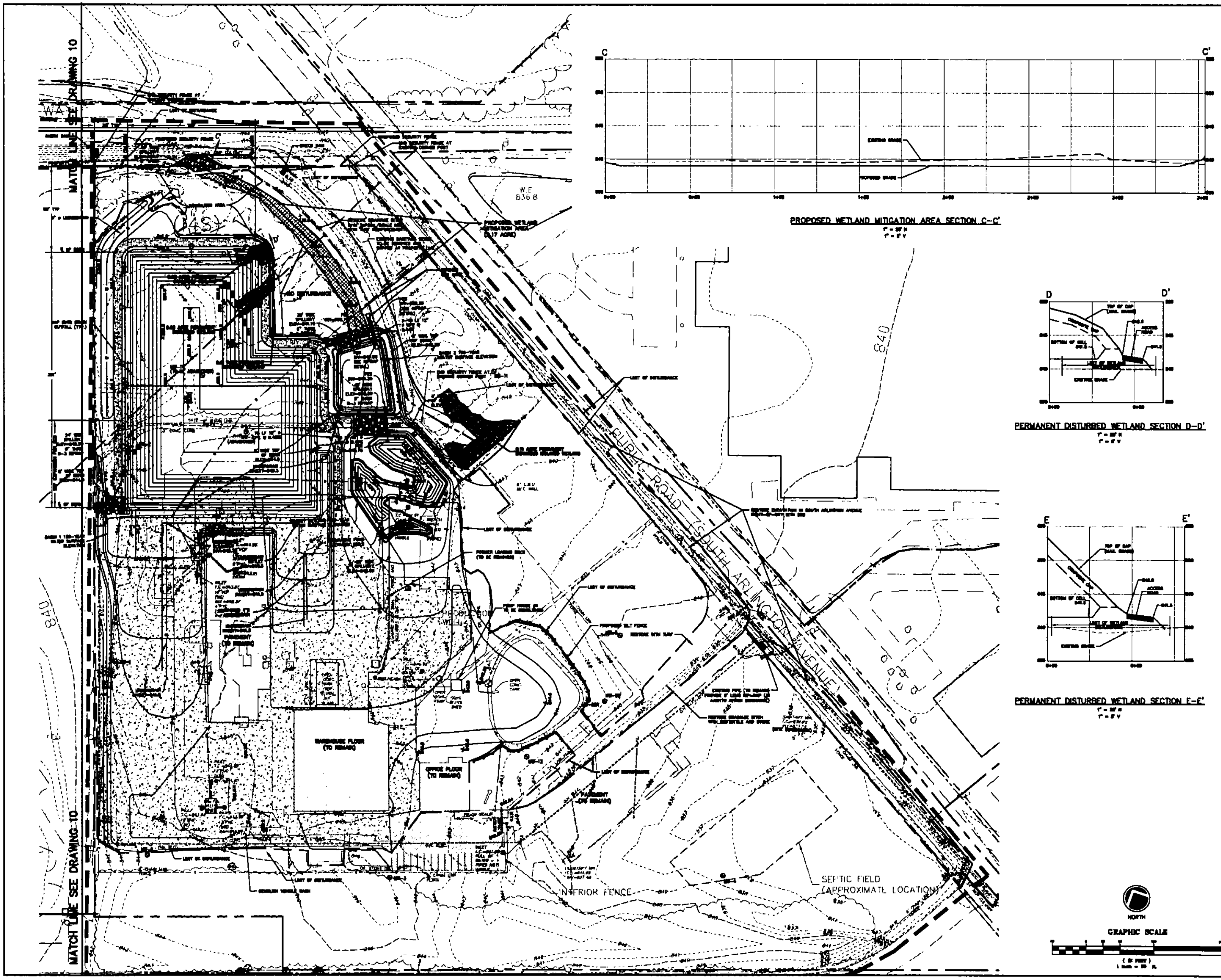
REFINED METALS CORPORATION
BEECH GROVE, INDIANA

CORRECTIVE MEASURES DESIGN
FINAL DESIGN
AMMENDED

SOIL AND SEDIMENT
EXCAVATION PLAN (WEST)

8A

Scale	1"=50'
	J.W.D.
	P.S.C.
	J.W.D.
	P.O.S.
	2003-1046
	8 OF 12



LEGEND

- Existing Contour
- Existing Building
- Former Building Footprint
- Existing Edge of Paving
- Existing Right of Way
- Existing Tree Line
- Existing Wetland Limit Line
- Existing Flood Plain Limit Line
- Existing Lot Line
- Property Line (Approximate)
- Existing Sanitary Sewer
- Existing Stormwater Line w/ Inlet
- Existing Water Line
- Existing Gas Line
- Existing Electric Line
- Existing Utility Pole
- Proposed Security Fence
- Monitoring Well
- Area to be Stabilized with 6" Thick Crushed Stone or Recycled Concrete
- Existing Impervious Surface to Remain

NOTES:

1. TOPOGRAPHIC SURVEY WITHIN REFINED METALS PROPERTY OBTAINED FROM FIELD SURVEY PERFORMED BY THE SCHNEIDER CORPORATION AUGUST, 2010. ORIGINATING BENCHMARK INDIANA DEPARTMENT OF TRANSPORTATION BRONZE DISC STAMPED "MAR 6-364" ELEVATION 882.48 (NGVD 29).

2. TOPOGRAPHIC INFORMATION OUTSIDE OF REFINED METALS PROPERTY OBTAINED FROM IMAGIS CITY OF INDIANAPOLIS BASED ON NGVD 29.

3. BUILDINGS ON THE REFINED METALS PROPERTY HAVE BEEN DEMOLISHED, EXCEPT PUMP HOUSES #1 THROUGH #4.

ADVANCED GeoServices

Engineering for the Environment. Planning for People.™

REFINED METALS CORPORATION
BEECH GROVE, INDIANA

CORRECTIVE MEASURES DESIGN
FINAL DESIGN
AMMENDED

RESTORATION AND FINAL EROSION AND SEDIMENT CONTROL PLAN (EAST)

9A

Scale	1"=50'
	J.W.B.
	P.S.G.
	J.W.D.
	P.G.S.
	2003-1046
	9 OF 12

ADVANCED GeoServices
Engineering for the Environment. Planning for People.™
1055 Andrew Drive, Suite A
West Chester, PA 19380-4293
tel 610.840.9100 fax 610.840.9199
www.advancedgeoservices.com

May 7, 2014

2003-1046-20

Mr. Jonathan Adenuga
United States Environmental Protection Agency – Region 5
Corrective Action Section 2
Land and Chemicals Division
77 West Jackson Boulevard
Chicago, IL 60604-3590

RE: Final Corrective Measures Design Changes
Refined Metals Corporation – Beech Grove, Indiana
IND 000 718 130

Dear Mr. Adenuga:

Refined Metals Corporation (RMC) and Advanced GeoServices Corp. (Advanced GeoServices) have reviewed your comments dated March 24, 2014, pertaining to the condition approval of the Corrective Measures Design (CMD) for the former RMC facility located in Beech Grove, Indiana. RMC agrees that the items identified in the attachment to that comment letter should not prevent the commencement of work. Nevertheless, RMC has corrected the remaining inconsistencies noted in items 2, 3, and 4 of the attachment to your comments. Corrected pages are attached to this document for you to incorporate into your copy of the Final CMD.

With respect to item 1 of the attachment to the March 24 comments letter, RMC and Advanced GeoServices offer the following response to support the use of the 1-hr storm duration for evaluation of pre- and post-development stormwater flows. Section 202.03 of the 1995 Stormwater Specifications Manual (used during the development of the original CMD) stated "a storm duration that maximizes the peak discharge for the pre-developed condition and a storm duration that maximizes required detention, retention volume for the post-development condition shall be used for the standard hydrograph routing method of detention design." The 1 hour storm duration was chosen as the appropriate event to utilize for the basin routing, and this storm event was approved by Indianapolis Department of Codes Enforcement (DCE) during the original design of the CMD stormwater management features. Subsequently to reaching this agreement, Section 202.03 was removed from the 2011 Manual; however, we feel that retaining the use of a 1-hour storm duration for the revised CMD is still appropriate. In Advanced GeoServices' engineering opinion, the 1 hour duration provides the greatest reduction in peak rate and volume over the multiple storm events analyzed during the design process.

RMC has initiated steps to implement the CMD and proposes the following schedule. It must be noted that RMC's is still in the midst of finalizing its contract with the selected remedial contractor and as such the start date and details of the contractor schedule is somewhat dependent on the contractor to complete.

- May 6, 2014: Complete response to USEPA comments and internal review of permit notification requirements.
- May 6 – May 30: Distribute revised stormwater design information to permitting bodies for review and permit revision/approval. We do not feel that any of the revisions made to the CMD and provided to USEPA as part of our February 28 letter (or this letter) are

significant. Therefore, this time for updating permits assumes a prompt review and approval. A prolonged permitting review could lengthen the schedule. Note: Indianapolis Drainage Permit is dependent on remedial contractor attendance at a pre-construction meeting with DCE.

- June 2 – 6: Advanced GeoServices mobilize with well driller to perform well abandonment.
- June 16 – June 20: Remedial contractor mobilization.
- June 19 – August 5: Demolition work.
- June 19: Remedial contractor begins site preparation (E&S, clearing, surveying, CRZ fence, etc).
- July 9 – 13: Advanced GeoServices and well driller perform new monitoring well installation.
- July 9 – July 29: Containment cell grading, SWM basin/piping construction, access road construction.
- July 28 – August 18: HZWU excavation, soil and sediment excavation, fill placement.
- August 18 – September 29: Containment cell cap construction, restoration and turf establishment.
- September 26 – October 6: Remedial contractor demobilization.

If you have additional questions, please do not hesitate to contact the undersigned at (610) 840-9100.

Sincerely,

ADVANCED GEOSERVICES

Jan S. Dobinsky
Senior Project Professional

Paul G. Stratman, P.E., P.G.
Senior Project Consultant

JSD:PGS:vm

Enclosures

cc: Matt Love, RMC
Ruth Jean, IDEM

10.0 POST CORRECTIVE MEASURES STORM WATER MANAGEMENT

Post corrective measures storm water management has been designed to comply with the *City of Indianapolis Stormwater Specifications Manual.* Section 302.03 of that document indicates that an increase in run-off volume is acceptable provided that sufficient detention/retention is provided to reduce the runoff flow (discharge rate). The required detention is as follows:

- 2-yr storm: $Q_{2proposed} \leq 0.5\ Q_{2existing}$
- 10-yr storm: $Q_{10proposed} \leq 0.5\ Q_{10existing}$
- 25-yr storm: $Q_{25proposed} \leq 0.75\ Q_{10existing}$
- 100-yr storm: $Q_{100proposed} \leq\ Q_{10existing}$

A comparison of existing and proposed conditions (based on 1-hr storm duration) is provided in the following table:

Condition	**Existing, $_e$**	**Proposed, $_p$**	**Difference**
Runoff Area (acre)	11.2	11.2	100%
Pervious Area (acre)	5.7	9.4	165%
Impervious Area (acre)	5.4	1.8	33%
V_2 2-yr Runoff Volume (acre-ft)	0.38	0.41	108%
Q_2 2-yr Runoff Flow (cfs)	8.6	3.3	38%
V_{10} 10-yr Runoff Volume (acre-ft)	0.87	0.90	103%
Q_{10} 10-yr Runoff Flow (cfs)	20.2	6.7	33%
V_{25} 25-yr Runoff Volume (acre-ft)	1.14	1.17	103%
Q_{25} 25-yr Runoff Flow (cfs)	27.2	8.4	31%
V_{100} 100-yr Runoff Volume (acre-ft)	1.59	1.62	102%
Q_{100} 100-yr Runoff Flow (cfs)	39.2	11.4	29%

The run-off area for the proposed conditions does not change significantly from the existing conditions. However, the proposed conditions indicate a significant reduction in impervious area. Supplemental drawing DA-01 depicts the existing runoff area; DA-02 depicts the proposed runoff area. HydroCAD results indicate that proposed run-off volume will be slightly larger than

As shown on Sheets 9 and 10, the post corrective measures storm water management will consist of a gravity storm water system that will convey storm water runoff from the former impervious manufacturing areas of the site and the southern and eastern portion of the proposed containment cell cap through storm water management basins situated along the south and east sides of the proposed containment cell. Pipe profiles and construction details are provided on Sheets 11 and 12.

The south storm water management basin (Basin 1) will cover approximately 1.6 acres and have a maximum storage capacity of approximately 47,500 cubic feet before reaching the emergency spillway. The calculated storage volume for the 100 year design storm event is approximately 24,000 cubic feet. The outlet structure will be a 12-inch diameter corrugated polyethylene pipe with an invert elevation of 840.20 that discharges to the east storm water management basin (Basin 2).

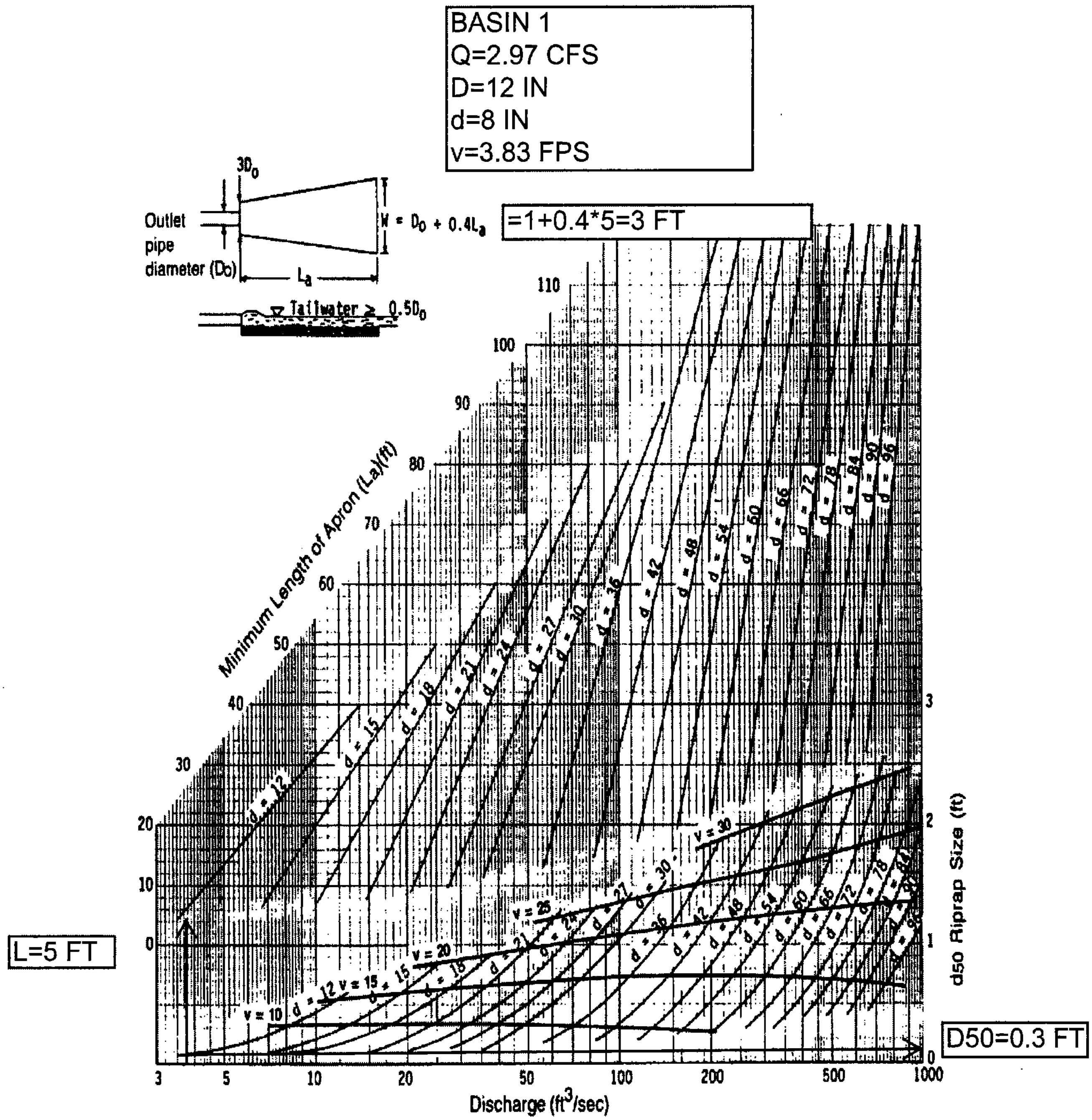
Runoff from the eastern portion of the Site enters the sediment forebay and pocket wetland prior to discharge to the Basin 2. The pocket wetland will cover approximately 14,000 sf. The outlet structure for the pocket wetland will be a 12-inch diameter CPE pipe. The Basin 2 will cover approximately 0.2 acres and have a maximum storage capacity of approximately 14,000 cubic feet before reaching the emergency spillway. The calculated storage volume for the 100 year design storm event is approximately 1,870 cubic feet. The primary outlet device for Basin 2 will be three (3) parallel 12-inch diameter pipes that discharges to a wetland mitigation area within a swale conveying flow to the existing drainage channel. The wetland mitigation area is approximately 7,000 sf. The proposed discharge towards the north coincides with the original storm water discharge for the manufacturing areas of the site prior to construction of the storm water collection and treatment system.

Grading and underdrains will convey the storm water runoff from the restored areas of the site to the storm water management basins, as shown on Sheet 9. The total drainage area to the basins is 11.2 acres with an average CN value of 90. HydroCAD® was utilized to perform the storm water management calculations following the SCS TR-20 Method. As presented on the calculations (Attachment C), the south basin (Basin 1) will detain a 1-hrstorm event and attenuate the flows as follows:

DESIGN STORM RETURN	INFLOW (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	STORAGE (cf)
2	5.15	2.07	841.20	4,946
10	10.80	2.97	841.69	12,198
25	13.84	3.27	841.90	16,581
100	19.05	3.65	842.19	24,404

The east basin (Basin 2) will detain a 1-hr storm event and attenuate the flows as follows:

DESIGN STORM RETURN	INFLOW (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	STORAGE (cf)
2	2.67	2.66	839.22	518
10	4.52	4.49	839.42	1,152
25	5.24	5.22	839.49	1,454
100	6.14	6.10	839.57	1,870



Curves may not be extrapolated.

FIGURE 304-04: Outlet Protection with Maximum Tailwater Condition
SOURCE: North Carolina Erosion & Sediment Control Planning & Design Manual, 09/01/88

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

REPLY TO THE ATTENTION OF: **LU-9J**

3/24/2014

Matthew A. Love
Manager-Regulatory Affairs
Exide Technologies
P.O. Box 14294
Reading, PA 19612-4294

Final Corrective Measures Design changes
Refined Metals Corporation
IND 000 718 130

Dear Mr. Love:

Thanks for your February 28, 2014, revisions to the final Corrective Measures Design (CMD) for the Refined Metals Corporation (RMC) facility in Beech Grove, Indiana. The final CMD was revised to address inconsistencies within the text and calculations of the CMD report based on comments provided to RMC on the CMD dated January 16, 2014. We have completed our review and at this time, EPA is providing you with approval. EPA believes that with this approval, RMC should now mobilize and start implementing the CMD as approved. A new schedule should be submitted to EPA within 30 days of receipt of this approval letter. In addition EPA is providing you in the enclosed attachment certain corrections to the text and CMD Tables. However, these corrections should not prevent RMC from commencing work at the facility.

If you have any questions, I can be reached at (312) 886-7954.

Sincerely,

Jonathan Adenuga
Corrective Action Section 2
Land and Chemicals Division

cc: Ruth Jean, IDEM

ATTACHMENT

1. RMC provides a table summary of existing and proposed runoff volumes and flows to meet the City of Indianapolis Stormwater Design and Construction Specifications. However, RMC should clarify the storm duration used in the calculations for the runoff flows for existing and proposed conditions in the table summary. In addition, RMC should provide the justification for the chosen storm duration based on the City of Indianapolis Stormwater Specifications Manual (Section 202.03).

2. The RMC response contains a typo for the storage capacity of Basin 1. HydroCAD results show a storage capacity of 24,404 cubic feet (CF). The response should be updated to revise the Basin 1 storage capacity to the correct capacity of 24,404 CF. In addition, page 10-3, Table for Basin 1 of the report should be revised to identify the storage for the 100-year Design Storm Return as 24,404 CF.

3. Page 10-3, Table for Basin 2 of the report shows the storage for the 25-year design storm return as 1,452 CF. However, the HydroCAD results show the storm return as 1,454 CF. The Table for Basin 2 should be revised to show the correct storage for the 25-year design storm return.

4. The Rip Rap design shows 2.91 CFS was used for the 10-year peak rate Qd. However, HydroCAD calculated 2.97 CFS for the 10-year peak rate. The rip rap calculations should be revised to include the correct 10-year peak rate.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

6/10/2010

REPLY TO THE ATTENTION OF:

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

Matthew A. Love
Manager-Regulatory Affairs
Exide Technologies
3000 Montrose Avenue
Reading, PA 19605

Pre- Final Corrective Measure Design

Refined Metals Corporation, Beech Grove, Indiana

IND 000 718 130

Dear Mr. Love:

The United States Environmental Protection Agency (U.S. EPA) has completed review of the April 12, 2010, Pre-Final Corrective Measures Design Work Plan for the Refined Metals Corporation. The enclosed attachment provides you with both EPA's and the Indiana Department of Environmental Management's preliminary comments to the design work plan. Please be advised that EPA will not approve the design work plan until all issues and concerns expressed in the enclosed Attachment and all future concerns that may arise with the design plan are properly addressed.

If you have any questions, I can be reached at (312) 886-7954.

Sincerely,

Jonathan Adenuga
Corrective Action Section
Enforcement Compliance Assurance Branch

cc: Bradley Martin, Techlaw Inc.,
cc: Ruth Jean, IDEM

ATTACHMENT

<u>Section 4.4.2, Surface Soil, Page 4-3:</u> Revise this section to discuss BHHRA results with respect to antimony, cadmium and selenium, which have been added as Contaminants of Concern (COCs) in the Design Report or provide the reasons for their addition as COCs.

<u>Section 1.2, Background, Page 1-2:</u> This section states, "A summary report of the decontamination and demolition activities is being prepared on a parallel track with preparation of this CM Design submission and will be included as an attachment to the Corrective Measures Completion Report to be provided following completion of the Corrective Measures." It is noted that this and other text have been added to this section. Revise this section to indicate that the summary report will describe the specific methods used to decontaminate the buildings prior to demolition, the types of waste that were generated during the remedial activities, and how this material was handled and disposed. In addition, ensure that the text of this section indicates that the summary report will describe the procedures that were followed during the decontamination of the pump houses, including a summary of any confirmatory sampling results. Finally, revise the discussion in Section 2.1, Facility Location, to reflect the changes made to Section 1.2.

<u>Section 5.4, Containment Cell, Page 5-4:</u> This section states, "The specific materials to be utilized for the cap will be determined based upon slope stability calculations in the final configuration of the cap." However, it was not clear why this information was not presented in this Design Report. Please revise the Design Report to address this issue.

<u>Section 5.5.2, Pg. 5-7, MNA groundwater Monitoring:</u> As described in the text, the frame work for the MNA has some shortcomings and does not comport with what EPA requested in the Final Decision and Response to comments for the selection of Remedial Alternatives:

The section indicates that new groundwater monitoring well CC-4 will be used as a surrogate well for abandoned monitoring wells MW-7 and MW-10; however, justification for monitoring well CC-4 being appropriate for evaluating contamination previously noted at wells MW-7 and MW-10 was not included. Revise the Design Report to include information on the Monitored Natural Attenuation (MNA) monitoring well locations and their appropriateness for assessing conditions at the site;

The section indicates that chemical analysis will be performed on soil samples from the newly installed monitoring wells CC-1 – CC-4, however, the number and depth of samples were not specified and the purpose of these data and how these results would be evaluated was not clear. Revise this section to include more details on the proposed soil sampling. The statement "sampling and evaluation of data being performed in relation to MNA of lead and arsenic in groundwater are considered components of RCRA corrective measures" is somewhat unclear and needs further clarification.

We have included in this Attachment, a September 2000 Memorandum titled "Transmittal of Monitored Natural Attenuation Framework". We recommend that you use some of the strategies described in this MNA framework to help you in developing an adequate MNA plan.

Section 6.3, Pg. 6-6, Containment Cell Construction: As indicated in this text, there appears to be some discrepancies in the groundwater elevation at the site. The discrepancies in the current groundwater elevation and the proposed bottom elevation of the Containment Cell would result in a Bath-tub effect. This is an important issue that must be resolved ahead of any development of the Containment Cell construction details. RMC must submit to EPA evidence that the groundwater elevation issues are adequately addressed prior to approval of the Containment Cell construction details.

Section 6.3 , Pg. 6-7: The text states that MW-2s, MW-2D, MW-7 and MW-10 will be abandoned prior to the start of construction of the Containment Cell. However, monitoring wells CC1 through CC4 proposed specifically for monitoring the effectiveness of the Cell are insufficient. Based on the size of the Containment Cell, the numbers of proposed wells (CC1- CC4) are insufficient to monitor the entire circumference of the Containment Cell. The number of monitoring wells must be increased especially on the eastern, western and southern portions of the Containment Cell.

Also, this section indicates that existing groundwater monitoring wells MW-2s, and 2D, MW-7 and MW-10 will be abandoned by Refined Metals prior to the start of the construction of the containment cell. Only well MW-10 is visible on the current version of Sheet 5, Containment Cell Construction, Filling and Capping Plan. In addition, Sheet 5 of the Preliminary Design Report indicates that well MW-2, not MW-2s will be abandoned. Revise this section to correctly reference well MW-2 and not MW-2s. Also, revise Sheet 5 to indicate the locations of all four wells that will be abandoned. Finally, revise this section to describe the procedures that will be followed during the abandonment of the four wells as requested by Specific Comment 14 on the Preliminary Design Report and

This section indicates that materials with a total lead concentration greater than the calculated Preliminary Remediation Goal (PRG) of 920 milligrams per kilogram (mg/kg) will be placed in the containment cell, but does not indicate the proposed analytical method or sampling frequency that will be used to collect and analyze the samples. In addition, this section indicates that materials with total lead concentrations less than 400 mg/kg will be approved for unrestricted use throughout the site. Revise this section to indicate the proposed analytical method and sampling frequency that will be used to collect and analyze the materials for lead as requested by Specific Comment 15 on the Preliminary Design Report, and to discuss why materials with total lead concentrations of less than 400 mg/kg will be approved for unrestricted use on the site.

<u>Sections 6.4.2.1, 6.4.2.2, Pg. 6-10, 6-1 and Section 02210:</u> These sections deal with materials for used in excavation backfill and for placement in the onsite Containment Cell. The terms Granular fill, Structural Soil and General Site fill as defined in **Section 02210** are somewhat confusing and does not comport with how these materials are proposed for use in sections **6.4.2.1 and 6.4.2.2.** Firstly, Granular fill (crushed stone) as defined in section **02210** will only be used for backfill beneath the water table. However, the text also states that contaminated crushed concrete retrieved from the RMC facility will also be used as backfill material beneath the water table. It is not clear if RMC is implying that imported clean crushed stone is the same as crushed contaminated concrete retrieved from the site. Also, RMC needs to explain the engineering method they intend to use in order to place crushed contaminated concrete beneath the water table at the site.

Secondly, Structural fill as defined in Section **02210** is to be free of organic mater, debris, roots e.t.c. However, the text also states that crushed contaminated concrete/asphalt, and unrestricted fill material (structural fill) will be used as in excavation backfill. It is unclear what is meant by unrestricted fill material. Also asphalt contains organic matter. Therefore, it contradicts the definition of Structural fill as defined above. Also, this section indicates that the crushed concrete and asphalt will be sampled, but does not describe what level of contamination in the crushed concrete and asphalt would be deemed acceptable for use as backfill

A distinction between materials to be used in excavation backfill and those placed in the onsite Containment Cell must be clearly and unambiguously established. For the purpose of clarity, materials to be used in excavation backfill must be clean imported materials. EPA will not oppose the placement of crushed Concrete/Asphalt in the onsite Containment Cell, providing these materials do not compromise the integrity of the Containment Cell cover.

<u>Section 6.4.2.1, Pg. 6-10, Para. 3:</u> The statement regarding side wall sampling at HWMU boundaries is somewhat convoluted. The text's artificial reference to some different standards for closure versus corrective action needs to be further explained. Regardless of this obscure standard, confirmatory sampling of all sidewalls should be performed using the appropriate standard.

<u>Section 6.4.2.1, Outdoor Waste Pile, Pg. 6-11, Para.1:</u> Text states that following approval of confirmatory sampling by the Engineer, the resulting excavation will be backfilled. RMC needs to explain what confirmatory sampling the Engineer is providing. Attachment **A** implies that confirmation would be based on analytical data (XRF and laboratory analysis). Attachment **D** also seemed to imply that post excavation confirmation sampling will be implemented by the QA. It follows that the Engineer can only confirm the elevation of excavation and not the actual laboratory chemical analysis. Therefore, all post excavation confirmatory sampling must have documented laboratory results prior to backfilling.

<u>Section 6.5, On-Site Corrective Measures, Page 6-13:</u> This section contains a reference to Remedial Action Levels (RALs) that conflicts with information presented on Page 6 of the Statement of Basis. The second sentence of this section states "Non-HWMU soil excavation areas included the former manufacturing area (referred to as the "on-site area" in the BHHRA), lawn and wooded area (referred to "grassy area" in the BHHRA) of the Site that are outside of the HWMUs and exceed the calculated RALs of 4,954 and 8,470 mg/kg total lead, respectively." The RALs listed at the bottom of Page 6 in the Statement of Basis, however, indicate an RAL of 8,470 mg/kg for the onsite manufacturing areas and a RAL of 4,954 mg/kg for the onsite grassy areas. Revise this section to resolve this discrepancy.

<u>Section 6.6, offsite Corrective Measures:</u> The Design Report does not include a sufficient discussion of the implementation of a deed restriction on the Citizen's Gas property. Such a discussion was required by the Final Decision. Revise the Design Report to include a discussion of implementation of the deed restriction for the Citizen's Gas property, as required by the Final Decision. In addition, revise the Design Report to discuss in more detail the onsite deed restrictions that will be implemented. Ensure that the Design Report discusses the placement of institutional controls to restrict the use of the property to only commercial/industrial land use, and a deed restriction preventing the installation of onsite potable groundwater wells that are required by the Final Decision.

Attachment B, Construction Specifications, Section 02210, Earthwork, Part 2, Products, Section 2.1, Structural Soil Fill, Page 02210-3: This section indicates that structural soil fill will be analyzed for antimony, arsenic, cadmium, lead and selenium but does not specify the proposed analytical method. Revise this section to indicate the proposed analytical method. In addition, include a discussion justifying why sampling for Volatile Organic Compounds (VOCs) and Semi-volatile Organic Compounds (SVOCs) is not proposed for Structural Soil Fill.

Attachment B, Construction Specifications, Section 02210, Earthwork, Part 2, Products, Section 2.2, General Soil Fill, Page 02210-3: This section indicates that general site fill will not require analytical testing prior to use as fill, but does not justify this conclusion. The first two sentences of this section state "Following completion of proposed remediation and receipt of acceptable confirmatory sampling results, the Contractor may cut into areas protruding above the proposed subgrade for final grading and utilize cut materials as fill in low areas. The cut material will be considered General Site Fill and must meet the general geotechnical requirements for structural soil fill and be approved by the QA Representative but will not require analytical testing." Revise this section to provide justification for the conclusion that general fills will not require analytical testing.

Attachment D, Construction Quality Assurance Plan, Appendix A, Confirmatory Sampling, Page A-4: This section does not describe the proposed confirmatory sampling plan. The last sentence of the second paragraph of this page states "Sheet 7 of the design drawings and the actual locations will be determined randomly utilizing a 10 foot by 10 foot grid superimposed over the excavation area." Revise this section to discuss how many samples will be collected from each 10 foot by 10 foot grid.

In addition, this section discusses sending 20 percent of X-Ray Fluorescence (XRF) screened soil samples for laboratory analysis, and developing a correction factor based on field XRF and laboratory results, but does not describe the limits of acceptable correlation between field XRF and laboratory analysis. Revise this section to discuss the acceptable range of correlation between field XRF and laboratory analysis and to indicate the specific analytical method that will be used by the laboratory.

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

The Engineering Section has reviewed the Draft Preliminary Corrective Measures Design for Refined Metals in Beach Grove, Indiana. The current report does not contain significant material for an engineering approval.

1. Provide the following detailed calculations showing that this cell is designed properly:
    a. Slope stability calculations
    b. Soil erosion calculations (e.g.., RUSLE)

Section 6.3 Containment Cell Construction

2. Revise the drawings to show the minimum 3% slope of the top of the cell. If necessary, provide the contours on the top of the cell at 1 foot intervals.

Closure Cost-estimates

3. Include the following cost:
    a. Closure Certification
    b. Contingency Allowance (20% recommended by EPA Cost Pro)

OLQ Chemistry Services Section
Science Services Branch

1. In Appendix A Section 2.3, Hazardous Waste Management Units, the consultant proposes closure sampling based on XRF, a screening instrument, after correlations with laboratory results of 20% of the samples. This section states that laboratory results will be evaluated against the corresponding average XRF concentration and a correction factor (regression equation) will be developed for each parameter. It should be noted that a minimal acceptable regression (r^2) would be 0.821. Due to relative large number of samples, this procedure is acceptable if the minimum acceptable $r^2 = 0.821$. If this correlation is not achieved then another 10% of the samples will need to be analyzed. If the correlation is still not achieved, then all samples will need to be analyzed.

2. Appendix D, Sampling and Analysis Plan, Section 6.5.3, Matrix Spike Samples, it is unclear if enough sample volume will be collected to perform a matrix

spike/matrix spike duplicate analysis. The consultant should collect enough sample volume to perform a matrix spike and matrix spike duplicate.

3. Appendix D, Sampling and Analysis Plan, Table 3, it states that samples from the HWMU, non-HWMU onsite areas, and offsite areas will be collected in zip lock baggies. Soil samples that will be sent to the laboratory for confirmation analysis should be collected an either a plastic or glass container provided by the laboratory. Table 3 should be amended to reflect this change.

[redacted] 15, 2009

[redacted]

[redacted]

BACKGROUND INFORMATION

Refined Metals Corporation is located at 3700 South Arlington Avenue in Marion County, Beech Grove, Indiana, approximately four miles south-southeast of downtown Indianapolis. In 1968, the property was developed as a secondary lead smelter by National Lead. National Lead operated the facility from 1968 through 1980, when it was sold to Exide Corporation. In 1985, the site was purchased from Exide Corporation by RMC. RMC continued to operate the facility until the cessation of operations on December 31, 1995. From April 14, 1995 through December 31, 1995, operations were reduced to enriching and casting lead ingots from off-specification lead products. Since 1996, no operations have taken place at the facility. Soil and groundwater in several areas at the facility are contaminated at levels above appropriately protective risk-based screening thresholds. Offsite contamination has also been reported north of the facility and in a drainage ditch east of the facility and at the adjacent Citizen's Gas Property west of the facility.

Remedial Alternative Selected

Following the conclusion of the facility investigations, a Statement of Basis was issued for public review and comment from June 27, 2008 to August 11, 2008. The Proposed remedies consisted of excavation of highly contaminated soils and sediments, incorporation of the excavated soils and sediments in an onsite Containment Cell, placement of institutional control on the facility and monitored natural attenuation. We received a number of written comments from the Citizens Gas Energy Group and the City of Beech Grove, Indiana. We have prepared responses to all these concerns and comments. In sum, one substantive change to the Statement of Basis was made. The proposed remedy was modified to address concerns regarding the location of the proposed Containment Cell. The attached Final Decision and Response to Comments describes in detail received comments, our responses and the selected remedy for the Refined Metals Corporation facility.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
FINAL DECISION AND RESPONSE TO COMMENTS
FOR SELECTION OF REMEDIAL ALTERNATIVE

FOR
REFINED METALS CORPORATION FACILITY
BEECH GROVE, INDIANA

September, 2009

FINAL DECISION AND RESPONSE TO COMMENTS
SELECTION OF FINAL REMEDIAL ALTERNATIVE
FOR
Refined Metals Corporation Facility
Beech Grove, Indiana

Introduction

This Final Decision and Response to Comments (FD/RC) is presented by the Environmental Protection Agency (EPA) for the Refined Metals Corporation (RMC) Facility located in Beech Grove, Indiana. The FD/RC includes, as Attachment I, the previously issued Statement of Basis. The Statement of Basis outlined potential remedial alternatives at the Facility as well as EPA's proposed remedy and was made available for public review and comment from June 27, 2008 to August 11, 2008. This FD/RC selects the final remedy to be implemented at the Refined Metals Corporation Facility based on the Administrative Record and public comments. EPA's Response to Comments addresses substantive comments received on the Statement of Basis during the 45 day public comment period.

Assessment of the Site

The response action documented in this FD/RC is necessary to protect human health and the environment.

Selected Remedy

EPA has selected the following remedial components as the remedy to address contaminated soil, groundwater and sediment at the Refined Metals Corporation Facility:

For lead in onsite soils and sediments, as well as offsite soils along the Arlington Avenue right-of-way, the railroad right-of-way, and the Big Four Road right-of-way, RMC will implement the following tasks as described in the Statement of Basis:

- Excavation of the most highly contaminated soils and sediments,
- Demolition of the Material Storage Building, Battery Breaker Building, Filter Press Building, Waste Water Treatment Building and Surface Impoundment, and
- Placement of institutional controls to restrict the use of the property to only commercial/industrial land use.

To assure safe and effective long-term management of the excavated soils and sediments as well as debris and rubble generated from the excavation and demolition, RMC will implement the following tasks as described in the Statement of Basis, except that the location of the Containment Cell has been changed:

- Construction of a Containment Cell that will be located in the northwest portion of the RMC property, north of the former operational area and parking areas, and west of the drainage ditch,
- Placement of excavated soils and sediments, as well as the debris and rubble from the building demolition in an onsite Containment Cell,
- Encapsulation of the excavated soils and sediments beneath an impermeable geomembrane cap covering the entire footprint of the Containment Cell and a vegetative cover above the geomembrane,
- Establishment of long-term operation, maintenance and groundwater monitoring of the Containment Cell including existing monitoring wells, and
- Placement of institutional controls on the Containment Cell to prevent any disturbance, excavation, or other activity that might result in a release of any materials contained in the cell.

To manage any excavated soils and sediments as well as any demolition debris or rubble that is not safely managed in the onsite containment cell, RMC will implement the following task:

- Shipment of these materials offsite to another facility for recycling or disposal in accordance with all applicable Federal, State and local regulations.

For Lead in soils at the offsite Citizens Gas property: The commercial/industrial cleanup standards are applicable to this property, and EPA agrees that no remediation is warranted provided that the future land use is restricted to commercial/industrial. Thus, the selection of this final remedy requires implementation of a deed restriction on the Citizens Gas property to ensure that its use is restricted to only commercial/industrial. Citizens Gas and RMC have reached an agreement regarding the land use restriction and the majority of comments raised by Citizens Gas on EPA's draft statement of basis have been rendered moot. Some construction work will be performed under this agreement between RMC and Citizens Gas, but independent of this final remedy.

For On-site Groundwater: To prevent human consumption of groundwater at the Facility, RMC will place a deed restriction preventing the installation of potable groundwater wells at the Facility. Institutional controls are also necessary to prohibit the use of shallow on-site groundwater as a drinking water source and restrict construction activities in on-site areas where humans may come in direct contact with shallow groundwater. In addition, Monitored Natural Attenuation (MNA) will be implemented as the principal means of restoring the on-site contaminated groundwater at the Facility. Monitored natural attenuation (MNA) is the stabilization and long-term shrinking of a contaminant plume by natural processes such as microbial degradation. The major component of MNA as a remedial alternative would be the long-term monitoring program to provide initial and continuing confirmation that the predicted biological activity and/or reductions in contaminant concentrations occur and remain effective. Monitored Natural Attenuation must demonstrate reduction or stabilization of lead within 10 years of this Final Decision. Within this reasonable time frame (10 years), we expect that monitored natural attenuation will restore the on-site groundwater such that it would be available for use as a source of commercial or residential drinking water.

Documents to be submitted:
RMC shall submit to EPA for review and approval within 60 days of this Final Decision a Corrective Measures Implementation (CMI) workplan for the excavation and off-site treatment/disposal, the building demolition, and the construction of the Containment Cell for lead contaminated soils and sediments. The design work consists of the design plans and specifications, proposed remediation objectives, construction cost estimate, construction quality assurance objectives, waste disposal requirements, project schedule, quality assurance project plan, Community Relations Plan, sampling and analysis plan, an air deposition management plan and health and safety plan. RMC shall implement the approved final design, incorporating EPA comments. Remedy construction must be completed within one year of this Final Decision, and a Construction Completion Report and O&M Plan must be submitted to EPA for review and approval at that time. In the report, a registered professional engineer and the RMC Project Manager shall certify that the remedy for lead-contaminated soils and sediments from these areas have been conducted in accordance with the EPA-approved final design and specifications, to the best of their knowledge, and cleanup objectives have been attained. The report shall include as-built drawings signed and stamped by a registered professional engineer. RMC must implement any approved final O&M Plan, incorporating EPA comments.

The operation and termination of the MNA remedy must also be described in the CMI workplan to be submitted by RMC for approval by EPA. In the CMI workplan, RMC will propose for EPA approval the criteria for measuring satisfactory progress. Every 2 years after the workplan approval, RMC must submit a report assessing whether MNA is progressing satisfactorily. If after 10 years the comprehensive groundwater monitoring program does not demonstrate that MNA is performing as expected, then RMC must propose an alternate remedy for EPA approval, and then implement the approved alternate remedy to achieve the corrective action objectives for the groundwater remediation.

Other Certification, Monitoring, Reporting, Institutional Control, and Financial Assurance Requirements.

As part of the Corrective Action, RMC will:

- Provide certification by a responsible corporate officer or duly authorized representative of all documents submitted pursuant to this Final Decision, as required in the Consent Decree entered in this matter.
- Implement institutional controls for the land, soil, and groundwater portions of the RMC Facility that are the subject of this Final Decision. The institutional controls shall ensure

that RMC property use remains industrial/commercial; the soil and onsite Containment Cell at the facility are not disturbed in a manner that poses a risk to workers or interferes with the implementation of the final remedy; groundwater monitoring wells are maintained until the MNA criteria approved in the CMI workplan are achieved; and the wells are approved for abandonment by EPA.

- Within 30 days of receipt of this Final Decision, provide detailed estimate of capital costs for implementing the final remedy.

- Obtain financial assurance for completion of the final remedy, including operation and maintenance (O&M), within 90 days of the Final Decision.

- Submit CMI monthly progress reports to EPA during the design and construction phases detailing work performed to date, data collected, problems encountered, project schedule, and percent project completed. Progress reports are due by the 15th day of each month following the Final Decision. Submit CMI progress reports semiannually for O&M activities upon approval of the Construction Completion Report.

The final remedy selected by EPA meets the threshold criteria that reflect the performance standards that must be achieved, including:

- Protect Human Health and the Environment
- Attain Media Cleanup Standards Set by EPA
- Control the Sources of Releases
- Comply with Any Applicable Standards for Management of Wastes

The final remedy also considers balancing criteria that represent a combination of technical measures and management controls that helped identify the best remedy, including:

- Long-term Reliability and Effectiveness
- Short-term Effectiveness
- Reduction in the Toxicity, Mobility, or Volume of Wastes
- Implementability
- Cost

Public Participation and Comments

A forty-five (45) day public comment period was held from June 27, to August 11, 2008. Comments were received from Citizens Gas and the City of Beech Grove, Indiana during the public comment period.

Public Comments and EPA's Response to Comments

Comments received on the proposed remedy from the Citizens Gas/Citizens Energy Group and

City of Beech Grove were considered and addressed in the final remedy. As a result, the proposed remedy was modified by EPA to address concerns regarding whether the location of the Containment Cell for consolidation of remediation wastes ensured proper storm water management and potential future development of the RMC facility.

The following narrative summarizes written comments on the proposed remedy and EPA's response to each comment. Each comment is numbered and presented in italicized type. Citizens Gas, a neighboring property owner, raised a number of issues regarding the Statement of Basis in a September 9, 2008, letter. After reaching an agreement with Refined Metals Corporation, Citizens Gas withdrew all of its comments except the following:

1. Citizens Gas requested that the containment cell be located in the northwest portion of the Refined Metals Property, north of the former operational and parking areas and west of the drainage ditch.

Response: EPA agrees that the proposed location of the containment cell could have had some adverse impacts on Citizens' property. The original location was proposed based upon EPA guidance which suggested that it is appropriate to manage waste in its place rather than transfer it to another location. However, the policy allows, under certain conditions, hazardous wastes may be moved within such areas without triggering RCRA land disposal restrictions. Since the location proposed by Citizens Gas is not an uncontaminated area requiring further analysis and approval, the containment cell will be relocated.

2. Citizens Gas requested that Refined Metals be required to develop a storm water management plan both during and following construction of the corrective measures to prevent contaminated storm water from migrating onto Citizens Gas property.

Response: The relocation of the containment cell, as described above, and proper engineering design, should alleviate runoff from the Refined Metals property. The final design plan will be submitted to EPA for approval and the design will be properly engineered and aesthetically acceptable.

3. Citizens Gas requested that Refined Metals be required to develop an air deposition management plan that will prevent contaminants from becoming airborne during Refined Metals' implementation of its corrective measures.

Response: EPA agrees that airborne particulate matter generated during the excavation process should be addressed. EPA will require that RMC include a plan to prevent airborne particulate matter in its Corrective Measures Implementation (CMI) Plan.

City of Beech Grove Comments

The City of Beech Grove provided comments which focused on the future development potential of the property, specifically that the design, location, and timing of the action and the involvement of the City are critical. The following comments were raised:

1. The City requested that the following be considered in the decision regarding the containment cell:

- *a. Minimizing the volume of the contaminated media contained onsite (and thus the size of the cell) to the extent possible considering that off-site disposal is a viable option;*

- *b. Locating the containment cell in a manner that maximizes the acreage for development purposes, particularly indicating that locating along the boundary of Citizens Gas facility would be good from future reuse options;*

- *c. Sizing the containment cell in a manner that does not detract from the visual aesthetics of the site for potential future redevelopment (balancing vertical and horizontal dimensions); and*

- *d. Establishing a perimeter, access points, and access control for the containment cell to not limit future redevelopment.*

Response: As described above, EPA has agreed to relocate the containment cell to the northwest corner of the RMC property. The Containment Cell will not be any larger than necessary, and the design will be properly engineered and aesthetically acceptable. These issues will be addressed in the CMI workplan to be submitted to EPA for approval.

2. The City requested that EPA expedite the Workplan process so that implementation of the corrective measures can commence.

Response: EPA will work as expeditiously as possible to review and approve the Workplan for implementation of the Final Remedy. The Consent Decree related to this matter requires Refined Metals to submit to EPA for approval a Corrective Measures Implementation Program Plan within 60 days of receiving notification of the selected corrective measures.

3. The City requested that it be designated as a corresponding party in the Workplan development process and implementation of corrective measures activities, and that a standard and a process for ongoing communication with the City be incorporated into the Workplan.

Response: EPA has an entered Consent Decree with Refined Metals that outlines the requirements for communication regarding the development of plans and implementation of measures. EPA will keep the City informed about the process of implementing the Final Decision. EPA can share publicly available documents including workplans, reports, and correspondence. As part of the Corrective Measures, Refined Metals will prepare and implement a Community Relations Plan (CRP). The CRP will designate a public repository for information regarding the site.

Future Actions

On August 31, 1998, the United States District Court for the Southern District of Indiana entered a Consent Decree in the matter of U.S. v. Refined Metals Corporation. The Consent Decree requires RMC to implement this Final Decision. The Consent Decree also requires RMC to provide financial assurance for the corrective action work. The future actions, beginning with submission of the CMI Work Plan, will begin as described earlier in this Final Decision.

Corrective Action Complete Determination

Once RMC believes it has met its corrective measures obligations, it may send a request to EPA Regional office for consideration for a Corrective Action Complete Determination (CACD). This request should include a written explanation justifying how RMC has satisfied the criteria for the CACD, based on the information outlined in the February 23, 2005 EPA guidance on CACD.

Administrative Record

The Administrative Record upon which the final remedy was selected is available at the Beech Grove Public Library, 1102 Main Street, Beech Grove, Indiana and the 7th Floor Records Center at EPA Region 5, 77 W. Jackson Blvd., Chicago, IL.

Declaration

Based on the Administrative Record compiled for this corrective action, EPA has determined that the selected remedy selected for the RMC Facility is appropriate and is protective of human health and the environment.

Margaret Guerriero Director
Land and Chemicals Division
U.S. Environmental Protection Agency
Region 5

Date September 17, 2009

Attachments

FINAL CORRECTIVE MEASURE DESIGN

Prepared For:

REFINED METALS CORPORATION
Beech Grove, Indiana

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Final CM Design
Refined Metals Corporation
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1.0 INTRODUCTION

1.1 GENERAL

Presented herein is the design report describing the proposed Corrective Measures to be completed by Refined Metals Corporation (RMC) to address elevated concentrations of lead and associated inorganic compounds in soil, sediment and groundwater identified on and around the RMC facility in Beech Grove, Indiana. The design report, in conjunction with the design drawings, specifications, Construction Quality Assurance Plan, and other attachments, comprises the Corrective Measures Design (CMD). The CMD is being submitted pursuant to the requirements of a Consent Decree negotiated between RMC, the United States Environmental Protection Agency (USEPA) and Indiana Department of Environmental Management (IDEM) Civil Action No. IP902077C.

This submission of the CMD is intended to represent a Final level of completion. The format and level of detail of the CMD process represent a hybrid between the highly structured requirements identified in the Consent Decree, and the single submission format requested in the Final Decision Document. As agreed upon between representatives of RMC, USEPA and IDEM, the Preliminary submission presented the major design components at approximately a 20 to 30% level of completion to obtain regulatory consensus. This Final submission has been developed to advance the amount of detail to a level of 100%. The general configuration of the major design components presented in the Preliminary submission (including containment cell location; excavation limits and confirmatory sampling techniques; pre and post-remediation storm water management strategies; and anticipated permitting requirements) have not changed. This submission includes attachments presenting construction specifications; Construction Quality Assurance Plan; Inspection and Maintenance Plan (including groundwater monitoring plan); engineering calculations; cost estimates; and construction schedule. The design drawings have been advanced to include additional details and schematics, sequence of construction information, and construction notes.

1.2 BACKGROUND

The Refined Metals Corporation (RMC) Beech Grove facility (Site) was the location of a secondary lead smelting and refining operation from 1968 through 1995. The general location of the Site is shown on Figure 1 and a detailed plan of the Site is shown on Sheet 1 of the design drawings. During its operational life, the facility handled hazardous materials or hazardous wastes under the Resource Conservation and Recovery Act (RCRA). These primarily consisted of lead acid automotive and industrial batteries, and lead-bearing materials that were processed for lead recovery.

In accordance with the requirements of RCRA, the facility completed and submitted a RCRA Part A permit application. On November 19, 1980 the facility was granted approval to operate two hazardous waste management units under Interim Status: 1) indoor waste piles; and 2) outdoor waste piles. Facility documents also identify a surface impoundment (lagoon) as a RCRA permitted unit; however, the lagoon does not appear to have been included on the Facility Part A permit until after 1991. The lagoon was, and still is, used to collect and manage facility storm water runoff. See Sheet 1 of the design drawings for the location of the RCRA Hazardous Waste Management Units (HWMUs).

The former indoor and outdoor waste piles were removed when normal facility operations ceased. The site sat idle after December 31, 1995 except for the wastewater treatment system which remained in operation to collect and manage storm water runoff from the lagoon and other site areas. Between August 2009 through early-January 2010, all buildings and structures were decontaminated and demolished, with the exception of four pump houses and the lagoon which remained in operation for on-site storm water management. Decontamination and demolition activities were performed in accordance with the *Draft Decontamination and Demolition Plan* (Advanced GeoServices March 4, 2009) and the *Decontamination and Demolition Implementation Plan* (Focus Contracting, June 8, 2009) both of which were submitted, reviewed and approved by the USEPA and IDEM. A summary report of the decontamination and demolition activities is being prepared on a parallel track with preparation of this CM Design submission and will be included as an attachment to the Corrective Measures Completion Report to be provided following completion of the Corrective Measures. The summary report will describe the methods utilized for decontamination, the waste streams produced (including estimated quantities) and identify the final disposition (disposal or recycling) of the materials generated.

Throughout the decontamination and demolition process, storm water from the impervious former manufacturing area continued to be collected, treated as appropriate, and discharged to the City of Indianapolis POTW. The impervious ground surfaces within the former manufacturing areas (former pavement surfaces and remnant floor slabs) were cleaned as part of the decontamination and demolition activities. Storm water inlets/manholes, piping and pump house sumps were cleaned following final cleaning of the impervious Site surface areas to remove sediment and rinse water what may have been washed into the storm water system.

Storm water sampling performed after completion of site cleaning activities has demonstrated that storm water from the lagoon and cleaned surface areas of the site can be discharged without requiring pre-treatment. In an effort to reduce the hydraulic loading on the POTW, the City of Indianapolis requested that RMC cease discharge of the clean storm water to the sanitary sewer following completion of decontamination and demolition activities. In response, RMC submitted a request for a "No Exposure Certification for Exclusion from NPDES Storm Water Permitting" to allow surface discharge of the storm water been sent to the POTW. IDEM approved the request in May 2010 and since that time RMC has discharged storm water to the drainage ditch at the north end of the property using the existing system of pumps and internal conveyance piping. The existing pump houses and collection system (inlets and piping) will be demolished and/or sealed/plugged and the site regraded to gravity drain storm water as part of the corrective measures and HWMU closure site restoration activities. Demolished components will be salvaged (pumps and controls), recycled, and or disposed in the containment cell.

1.3 PURPOSE

On August 31, 1998 Refined Metals Corporation entered into a Consent Decree with the United States Environmental Protection Agency (USEPA) and the Indiana Department of Environmental Management (IDEM), Civil Action No. IP902077C. The technical objectives of the Consent Decree are as follows:

1. Effectuate closure of waste piles and surface impoundment by submitting a closure plan and post-closure plan, if necessary, and then to implement the plan(s) as approved;

2. Perform a RCRA Facility Investigation (RFI) to evaluate and determine the full nature and extent of releases and collect information necessary to support a Corrective Measures Study, or Interim Measures;

3. Perform Interim/Stabilization Measures to abate threats to human health and the environment;

4. Perform a Corrective Measures Study to develop and evaluate alternatives and to recommend a final corrective measure(s); and,

5. Perform Corrective Measures.

1.3.1 Waste Pile and Surface Impoundment Closure Investigations

Pursuant to Section VI, Paragraph 37 of the Consent Decree (Compliance Requirements for Closure), Advanced GeoServices Corp. (AGC) prepared a Closure Plan on behalf of RMC for the HWMUs. The Closure Plan was prepared in accordance with Indiana Department of Environmental Management (IDEM) Hazardous Waste Management Unit Closure Guidance (Waste-0013-ND) and Risk Assessment Addendum.

The Closure Plan (Version 3.0 dated July 17, 1999) was implemented between the fall of 1999 and spring of 2000. The results of the investigation conducted pursuant to the approved Closure Plan were presented in the Closure Investigation Report (AGC, June 2000). Comments on the Closure Investigation Report prompted additional soil sampling within the HWMUs in December 2001, January 2007 and August 2007. Results of the Closure Investigation activities were compiled in a Comprehensive Closure Investigation Report (AGC March 27, 2007), with an addendum containing supplemental sampling information on January 29, 2008 and a response to IDEM comments on April 8, 2008.

1.3.2 RCRA Facility Investigation

Pursuant to Section VI, Paragraph 42 of the Consent Decree (Compliance Requirements for Corrective Action), RMC prepared and implemented a RCRA Facility Investigation (RFI) Work Plan (AGC March 3, 1998) which was conditionally approved by the USEPA in writing on June 3, 1999. The RFI Work Plan was revised by AGC on July 7, 1999 in response to the USEPA conditional approval. Final USEPA approval of the RFI Work Plan was received in a letter dated August 17, 1999. The USEPA approved RFI Work Plan was implemented by AGC on behalf of RMC in late 1999 and early 2000. A Phase I RFI Report was submitted by RMC on August 31, 2000. Based on the results of the Phase I RFI and as required by the USEPA, a Phase II RFI Work Plan was prepared and submitted (AGC December 20, 2000). Following minor revisions (based on USEPA comments) in an addendum dated June 27, 2001, the Phase II RFI Work Plan was approved by the USEPA on July 13, 2001. The Phase II RFI Report was prepared and submitted by AGC on May 3, 2002 and subsequently revised in November 18, 2002.

1.3.3 Interim Corrective Measures

Results of the Phase I RFI identified elevated concentrations of lead in the shallow surface soil/sediment along the former railroad spur entering the facility from the railroad tracks north of the site. To reduce the potential for that soil/sediment to be eroded and transported to areas off-site RMC prepared a Interim Measures Work Plan (AGC December 20, 2000), consisting of a series of check dams across the drainage ditch that was approved by the USEPA on July 13, 2001. AGC implemented the Interim Measures Work Plan in September 2001. Those measures remain in-place to date and based on visual observations provide detention and filtration to storm water flow in the ditch. The check dams will remain in-place until remediation is performed in the drainage ditches on either side of the railroad spur. No other interim measures were performed or required at the facility.

1.3.4 Corrective Measures Study

The Corrective Measures Study (CMS) was performed in two phases pursuant to a CMS Work Plan (AGC April 21, 2003), as revised by AGC on July 11, 2003 and October 16, 2003 and conditionally approved by USEPA on November 5, 2003. The Phase I CMS consisted of supplemental soil sampling (including shallow surface soil in the mowed grass swale along South Arlington Avenue and drainage ditch along the CSX railroad tracks referred to in the RFI, CMS and herein as "sediment") and groundwater sampling (completed by AGC during the fall of 2003), and completion of a Baseline Human Health Risk Assessment (BHHRA) (performed by Gradient Corporation (Gradient)). The BHHRA separated the site into two exposure areas identified as "Grassy Areas" and "On-Site Areas". Figure 2 shows the specific areas represented by Grassy Areas and On-Site Areas. The results of the Phase I CMS were initially submitted in a report prepared by AGC on June 22, 2004. The USEPA issued written comments on August 17, 2004 and January 18, 2005 and the Phase I CMS Report was revised on May 6, 2005 and approved in writing by the USEPA on August 23, 2005.

The Phase II CMS consisted of the development and evaluation of cleanup options for those areas of the site impacted above action levels established in the BHHRA and accepted in writing by the USEPA in their approval letter dated August 23, 2005. The Phase II CMS also anticipated remediation of surface soils and sediment with total lead concentrations >400 mg/kg in the right-of-way for South Arlington Avenue, Citizens Gas property along the south side of the Citizens Gas security fence parallel Big Four Road, and drainage ditch within the CSX right-of-way. The Phase II CMS Report was originally submitted by AGC on October 21, 2005. The Phase II CMS Report was revised by RMC through a series of iterations promulgated by USEPA comment letters issued on April 19, 2006, July 13, 2006, November 30, 2006, March 1, 2007 and May 29, 2007. Conditional approval of the August 6, 2007 revision of the Phase II CMS Report was issued by the USEPA in a letter dated January 22, 2008.

1.3.5 Corrective Measures Design

This Corrective Measures Design (CMD) is being submitted to convey the design and construction elements of the Corrective Measures alternatives selected by the USEPA from the Phase II CMS Report and published in the Statement of Basis (USEPA June 2008). As agreed to by USEPA, IDEM and RMC, the CMD approach deviates from both the highly structured approach specified in the Consent Decree, and the single submission format specified in the Final Decision Document. It is believed that the agreed upon approach will both allow for regulatory input during the design process, while expediting the design schedule. The Preliminary Design representing approximately a 20 to 30% level of completion was submitted to USEPA and IDEM on January 8, 2010. Comments on the Preliminary CMD were received in written format in a letter dated February 25, 2010. The USEPA determined that based on the limited scope of comments on the Preliminary CMD that an "on-board" review meeting was not necessary prior to Pre-Final CMD preparation. On April 12, 2010, a Pre-Final CMD was submitted to the USEPA and IDEM. The Pre-Final CMD represented an approximately 90% level of completion. On June 10, 2010, the USEPA and IDEM issued comments regarding the Pre-Final CMD. This Final CMD reflects EPA and IDEM's comments regarding the Pre-Final CMD.

It should also be noted that pursuant to discussions between USEPA, IDEM and RMC it was agreed to include Closure of the Interim Status Hazardous Waste Management Units (Indoor Waste Piles, Outdoor Waste Piles and Surface Impoundment) as a component of the CMD. Inclusions of the Closure activities within the CMD allows the design efforts for both proposed remediation activities to proceed in parallel and provides USEPA relevant information regarding the Closure activities, and IDEM relevant information regarding the Corrective Measures. Additional information regarding the interrelationship between the USEPA and IDEM and the Corrective Measures and Closure is provided in Section 3.0.

1.4 ORGANIZATION

This Preliminary design report is organized as follows:

- Section 1.0 - Introduction (provided above);
- Section 2.0 - Facility Background, including operating history and regulatory status;
- Section 3.0 – Regulatory Purview;
- Section 4.0 – Nature and Extent of Contamination;
- Section 5.0 – Statement of Basis;

- Section 6.0 – Design Elements;
- Section 7.0 – Permitting Requirements;
- Section 8.0 – Public Relations;
- Section 9.0 – Schedule and Cost Estimate;
- Section 10.0 - Post Corrective Measures Storm Water Management; and,
- Section 11.0 – Post Closure Inspection and Maintenance.

2.0 FACILITY BACKGROUND

2.1 FACILITY LOCATION

The RMC facility is located at 3700 South Arlington Avenue in Beech Grove, Marion County, Indiana, and approximately four miles south-southeast of downtown Indianapolis. The Site occupies approximately 24 acres, of which approximately 10 acres represented the active manufacturing area (including paved areas and buildings). The remaining 14 acres include grass and wooded areas. The configuration of the Site is triangular, bounded by South Arlington Avenue (oriented in a north to south direction representing the hypotenuse), Big Four Road (along the base), and the common property line with a natural gas company (Citizens Gas) forming the third side. The northwest end of the triangle is truncated by a railroad right-of-way as depicted on Sheet 1 of the design drawings.

The Site is relatively flat with less than 10 feet of total relief. Natural site drainage is toward the north and east. The former manufacturing area included nearly 80,000 square feet (sf) of structures including the battery breaker, a wastewater treatment plant, a filter press, material storage building, a furnace room, metals refining area warehouse, a vehicle maintenance structure and offices. As indicated in Section 1.2, all of the structures were decontaminated and demolished to grade between August 2009 and January 2010, except the pump houses which were decontaminated but remain to manage storm water. Decontamination and demolition activities were performed in accordance with the *Draft Decontamination and Demolition Plan* (Advanced GeoServices March 4, 2009) and the *Decontamination and Demolition Implementation Plan* (Focus Contracting, June 8, 2009) both of which were submitted, reviewed and approved by the USEPA and IDEM. Summary information regarding the decontamination and demolition activities will be included as an attachment to the Corrective Measures Completion Report to be provided following completion of the Corrective Measures. As stated in Section 1.2, the summary report will include descriptions of the decontamination procedures, waste streams produced and final disposition of the materials sent off-site for disposal or recycling.

The floor slabs, foundations and site paving remain in-place. Debris resulting from the demolition activities was sent off-site for recycling or disposal, except for non-hazardous masonry rubble that was placed under a geomembrane cover within the footprints of the former battery breaker and material storage buildings to prevent infiltration of stormwater, create positive drainage and prevent the ponding of surface water. The paved surface areas drain toward catch basins situated around the Site. The catch basins in-turn, flow to the storm water pump houses. Originally, the storm water from the former manufacturing areas of the Site was discharged to the POTW by the pump houses. Since IDEM approval of a "No Exposure Certification for Exclusion from NPDES Storm Water Permitting" in May 2010, RMC has discharged storm water to the drainage ditch at the north end of the property using the pump houses. The existing pump houses and collection system (inlets and piping) will be demolished and the site regraded to gravity drain storm water as part of the corrective measures and HWMU closure site restoration activities. Demolished components will be salvaged (pumps and controls), recycled, and or disposed in the containment cell.

2.2 OWNERSHIP HISTORY

The Site was reportedly undeveloped woodlands until 1968. In 1968, the property was developed as a secondary lead smelter by National Lead. National Lead operated the facility from 1968 through 1980, when it was sold to Exide Corporation. In 1985, the Site was purchased from Exide Corporation by RMC. RMC continued to operate the facility until the cessation of operations on December 31, 1995. From April 14, 1995 through December 31, 1995, operations were reduced to enriching and casting lead ingots from off-specification lead products. Since 1996, no production has taken place at the facility and operations have been limited to operation of the wastewater treatment facility which was used to manage storm water runoff from the former manufacturing areas prior to 2009 demolition activities.

2.3 REGULATORY HISTORY

As stated above, following the promulgation of RCRA, the facility submitted a Part A RCRA permit application. On November 19, 1980 the facility was granted Interim Status as a hazardous waste treatment, storage and disposal facility. The RCRA Subtitle C units included indoor and outdoor waste piles (used to store batteries and lead-bearing wastes), and the 750,000-gallon concrete lined lagoon. A Part B application was submitted during the mid-1980s, although full RCRA permitted status was never granted. The EPA maintains that interim status was lost on November 8, 1985 as a result of RMC's alleged failure to comply with Section 3005(e)(2) of RCRA, 42 U.S.C. 6925(e)(2); RMC did not agree with this allegation.

RMC submitted a revised Part A application on October 26, 1988 requesting an increase in the storage volume for spent batteries. The request was granted on September 20, 1989. A subsequent revised Part A application was submitted to IDEM on December 7, 1990 for an additional increase in the storage volume of spent batteries, but IDEM denied the increase. RMC filed for a stay and was granted interim status. IDEM approved the revised Part A application on June 3, 1991 with the provision that it did not grant interim status under RCRA. The Part B application was not resubmitted. In 1994, the facility withdrew its Part A and Part B permit applications.

A site inspection was performed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980. In 1985, a preliminary assessment was performed under CERCLA. No further action was planned under CERCLA at that time.

3.0 REGULATORY PURVIEW

3.1 SEPARATION OF RESPONSIBILITIES

As stated above, the Consent Decree includes the United States Environmental Protection Agency (USEPA) and the Indiana Department of Environmental Management (IDEM) as regulatory participants. Section VI Paragraph 37 of the Consent Decree (Compliance Requirements for Closure) places responsibility for oversight of closure of the interim status hazardous waste management units (indoor waste piles, outdoor waste piles and surface impoundment (lagoon)) under IDEM. Oversight of work in all other areas is the responsibility of the USEPA. This has resulted in parallel investigation activities and slightly different remediation requirements, with the IDEM responsible for "Closure" of those portions of the RMC property contained within the footprint of the HWMUs and USEPA responsible for "Corrective Measures" of remaining on-site areas and all off-site areas.

3.2 HWMU CLOSURE

Irrespective of the slightly different remediation requirements, this Corrective Measures Design has been developed to include remediation required to affect Closure of the HWMUs. Closure activities specific to the HWMUs are presented separately in Section 6.4 of this Design Report and limits of soil remediation are depicted on Sheet 6 of the design drawings. HWMUs are being remediated to attain Closure to the default Industrial Closure Levels for soil, and groundwater at the lagoon, as established under the IDEM RISC Technical Guidance (Last Revised May 1, 2009) except for arsenic and lead in soil where alternate values will be utilized.

Results of soil sampling conducted within the footprints of the HWMUs are provided on Sheet 3 of the design drawings. Groundwater monitoring for the lagoon has been performed pursuant to the requirements of a Groundwater Monitoring Plan approved by IDEM (AGC, June 8, 2007). A discussion of the results of this groundwater sampling and groundwater sampling conducted in conjunction with the RFI is provided in Section 4.5 of the CMD.

3.3 CORRECTIVE MEASURES

The Corrective Measures activities related to soils and sediment to be completed under the purview of the USEPA are being performed specifically for lead. Within the off-site areas readily accessible by the general public, the remediation level for soil and sediment is 400 mg/kg total lead. On-site, soil remediation will be performed to achieve an area wide Preliminary Remediation Goal of 920 mg/kg. For site wide groundwater, the standards will be 0.010 mg/L for arsenic and 0.042 mg/L for lead, the same values to be applied to groundwater for Closure of the lagoon. The site wide groundwater values were previously identified in the Phase II CMS Report as approved by USEPA.

The Final Decision issued by the USEPA determined that a commercial/industrial cleanup standard applies to the neighboring Citizens Gas property and agreed with RMC's interpretation that except for a drainage ditch along the north side of the Citizens Gas property and soil remediation outside the security fence parallel to Big Four Road, no remediation is required on that property and placement of a deed restriction is the only action required as part of the Corrective Measures. RMC has been in discussions with representatives of Citizens Gas for the purpose of negotiating the language and implementation of the deed restriction. Although not required as part of the Corrective Measures, Citizens Gas has requested and RMC has agreed to perform a limited amount of surface soil remediation in conjunction with granting the deed restriction. RMC is planning to perform the surface soil remediation during the Corrective

Measures and HWMU Closure activities. Remediated soils from the Citizens Gas property will be consolidated in the containment cell.

Results of soil sampling conducted off-site are provided on Sheet 3 of the design drawings. A discussion of the results of the groundwater sampling conducted in conjunction with the RFI is provided in Section 4.5 of the CMD and is provided in Tables 1A through 1L. Sampling and evaluation of data being performed in relation to the Monitored Natural Attenuation (MNA) of lead and arsenic in groundwater are considered components of the RCRA Corrective Measure as they have been specified by the USEPA (rather than by IDEM as part of the HWMU closure), and are described in detail in the MNA Work Plan provided as Attachment H.

4.0 NATURE AND EXTENT OF CONTAMINATION

4.1 CONSTITUENTS OF CONCERN IN SOIL AND SEDIMENT

4.1.1 RCRA Facility Investigation

Environmental sampling, performed as part of the Phase I RCRA Facility Investigation (RFI) (sample locations RSB-01 through RSB-85) included sampling for arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver. While the results of the Phase I RFI sampling detected the presence of barium, cadmium, chromium, mercury, selenium and silver, with only some exceptions; concentrations of these parameters were consistently below the Region 9 Preliminary Remediation Goals (PRGs) used for screening results of the Phase 1 RFI sampling in the corrective action areas (i.e., areas outside the boundaries of the HWMUs). Therefore, only lead and arsenic were retained as constituents of concern in soil and sediment in corrective action areas. The Baseline Human Health Risk Assessment (BHHRA), performed as part of the Phase II RFI and revised during the CMS, focused exclusively on lead and arsenic. A detailed summary of the investigation activities and results are provided in the Phase I and Phase II (Revision 1.0) RCRA Facility Investigation Reports (Advanced GeoServices August 31, 2000 and November 18, 2002, respectively) and relevant addenda and response to comments. The final BHHRA is provided as an appendix to the Phase II CMS Report.

4.1.2 Closure Investigation

In addition to lead and arsenic, soil sampling performed as part of the Closure Investigation for the interim status Hazardous Waste Management Units (HWMU) indicated that antimony, cadmium and selenium are present in soil immediately beneath the HWMUs in some sample locations at levels exceeding the IDEM RISC Technical Guidance default values for soil. Therefore, antimony, cadmium and selenium are considered constituents of concern, in addition to lead and arsenic within the HWMUs. Results of the Closure Investigation are presented in the Comprehensive Closure Investigation Report (Revision 1.0) (Advanced GeoServices March 27, 2007) and supplemental data submitted in January, 2008.

4.2 BEHAVIOR OF LEAD AND RELATED CONSTITUENTS

A number of the materials formerly used at the facility have toxic characteristics; however, the principal material of concern is lead. Lead is a common metal, and can be found at an average concentration in excess of 30 ppm in natural soils and 1-10 ug/l in surface water. Most lead salts are fairly insoluble in water; however, the solubility depends on the pH, with solubility increasing in more acidic conditions. Movement of lead in soils depends on its adsorption, chelation with organic matter, and the precipitation of the less soluble salts. In general, lead reacts with soil anions or clays to form insoluble complexes, inhibiting its mobility. Lead can be ingested or absorbed by inhalation. Poisoning from acute exposure to lead is uncommon. The primary toxic effects from chronic exposure are on the blood and the nervous system. Antimony, arsenic, cadmium and selenium are all considered insoluble inorganic constituents and their behavior is generally similar to the behavior lead. The only notable difference is that arsenic is naturally occurring in regional soils at levels that have been noted to exceed the IDEM RISC Technical Guidance default values and arsenic is relatively more soluble than lead.

4.3 DISCUSSION OF SOURCE AREAS

Based on the documented operating history of the facility, results of the Closure and RFI sampling activities, and an understanding of the character of the mobility and transport of lead and arsenic, the most significant potential sources of contamination impacting surface and shallow subsurface soils at the facility during its operating history were erosion and transport of lead-bearing solids; fugitive dust; and filling performed using impacted soils or slag resulting from the furnace operations. Sampling activities were designed to target the areas of impact from each of the potential sources. Soil and sediment sample locations are depicted on Sheet 2 and the results of the sampling are provided on Sheet 3. A supplemental qualitative discussion regarding the sampling results is provided below.

4.4 EXTENT OF IMPACT

4.4.1 Drainage Ditches

Erosion and transport of lead bearing solids from sources, such as the outdoor waste piles or materials tracked from operating areas of the facility may have occurred before the facility was upgraded to capture and treat storm water falling in the active manufacturing areas of the facility. The impacts associated with the erosion and transport of lead impacted solids would be manifested in the form of elevated concentrations within drainage paths leading from the facility. Sampling was conducted in the drainage ditches along the railroad spur and tracks north of the former manufacturing area ("northern drainage ditch"), along the north side of the main driveway, and along South Arlington Avenue. The sampling focused on the centerline of the drainage ditches and identified soil/sediment impacted by lead in excess of 400 mg/kg. In the northern drainage ditch, lead exceeded 400 mg/kg to a distance of approximately 600 feet west of the northwest corner of the RMC property; in the driveway drainage ditch, lead exceeded 400 mg/kg along the entire length; and along South Arlington Avenue, lead exceeded 400 mg/kg from approximately 1,000 feet north to 1,000 feet south of the main driveway.

4.4.2 Surface Soil

Fugitive dust emissions are generated by traffic, wind and similar sources that cause dust on the ground surface, exposed waste materials and/or materials from production areas to become suspended in air and transported. Generally the particulate size of fugitive dust is large and as a result, the area impacted by the fugitive dust is relatively limited. Sampling determined that fugitive dust has caused some impacts to the surface soils on the adjacent Citizens Gas property west of the facility manufacturing area. Impacts from fugitive dust were not identified in off-site areas north, south and east of the facility, where the property boundaries are typically 200 feet or greater from the former manufacturing area.

A BHHRA was conducted for an exposure scenario intended to replicate workers at the Citizens Gas facility, the results of which were included in the Phase II CMS Report. The BHHRA evaluated the potential for the receptor to have adverse impacts from arsenic (using the 95% UCL) and lead (using the mean lead). The results of the risk assessment for arsenic determined that the total excess lifetime cancer risk on the Citizens Gas property is 8x10-6, with a Total Hazard Index of 0.05, which did not represent an unacceptable risk. The lead risk assessment predicted a 95th percentile fetal blood lead level (BLL) of 7.4 ug/dL, which is below the allowable maximum of 10 ug/dL. Through the BHHRA is was determined that lead and arsenic did not represent an unacceptable risk for the non-residential exposure scenarios evaluated on the Citizens Gas property and, therefore; remediation was not required as part of the Corrective Measures. As required by the Final Decision, RMC and Citizens Gas have been negotiating a deed restriction against future residential development of the property. Citizens Gas has agreed to record the required deed restriction if RMC performs remediation of a limited amount of surface soils. RMC has agreed to perform the remediation requested by Citizens Gas. RMC is planning to perform the surface soil remediation on the Citizens Gas property during the Corrective Measures and HWMU Closure activities and to consolidate the remediated soils in the containment cell.

4.4.3 Subsurface Soil

During the early operating history of the facility, feed materials destined for recycling and waste products resulting from the recycling process (i.e. slag) were managed on the unpaved exterior surfaces. As a result, shallow subsurface soils have become intermixed with materials containing high concentrations of lead. In addition, various modifications and expansions of the manufacturing area were conducted periodically that required minor amounts of grading. The results of these activities are elevated concentrations of COCs in the shallow subsurface soils. In most areas the depth of impact is less than 12-inches, with a few areas extending up to 36-inches. The only areas deeper than 36-inches are within the HWMU along the northern limits of the manufacturing area where areas of filling and disturbance are as much as 8-feet below existing ground surface. It was also determined that an area within the material storage building HWMU had impacted soil requiring remediation as deep as 6-feet.

4.4.4 Storm Water Lagoon

The storm water lagoon is an interim status HWMU. Sampling was conducted to characterize the nature of sediments within the lagoon and the impact of the lagoon on underlying soils. The results of the sediment sampling (CSED-1 through 4) in the lagoon identified concentrations of antimony, arsenic, cadmium and lead above the IDEM RISC industrial soil default values. The sediment is typically 6-12 inches in thickness and overgrown by cattails. The lagoon is lined by a geomembrane in poor condition and concrete. Sampling conducted during the initial investigation activities included the collection of soil samples from beneath the liner system (CSB-43 through 47). The results of that sampling identified one sample with an arsenic concentration slightly above the proposed cleanup level. It should also be noted that samples of storm water collected from the lagoon during and after decontamination and demolition activities did not exceed the discharge limits established by the temporary discharge permit and were included as part of the results that formed the basis for IDEM authorization for surface discharge of storm water.

4.5 GROUNDWATER IMPACTS

Groundwater conditions have been evaluated through the installation and sampling of twelve (12) shallow and two (2) deep monitoring wells. Monitoring well locations are shown on Figure 3. Groundwater in the shallow zone of saturation near the former manufacturing area occurs as perched zones within thin, laterally discontinuous layers of sand and sandy silts contained in clayey-silt and silty-clay glacial deposits. The monitoring wells identified as "deep" are screened within a middle perched zone located 75 to 85 feet below ground surface. "Depth to water" measurements indicate that the potentiometric surface of the middle perched zone is on the order of 14 to 17 feet below ground surface, while the shallow perched zone is typically less than 5 feet below the ground surface.

The results of groundwater sampling conducted as part of the RFI, Closure Investigation and CMS are provided in Tabular format on Tables 1A through 1L. The results for arsenic and lead are screened against the IDEM Industrial Default RISC Criteria 10 ug/L and 42 ug/L, respectively. (The 10 ug/L value for arsenic is the same as the MCL for arsenic). The remaining constituents are screened against the MCLs. A groundwater contour map is provided for the (January 2007) site wide sampling event on Figure 3. Total results for lead and arsenic from the January 2007 groundwater sampling event for the shallow groundwater wells are also presented on Figure 3.

A review of shallow groundwater sample results, obtained as part of the RFI and Closure activities (Tables 1A through 1L), shows that the current MCL for arsenic (10 ug/L) has been exceeded on more than one occasion at groundwater monitoring wells MW-1, MW-2, MW-3, MW-7, MW-8 and MW-10. The 42 ug/L IDEM Industrial Default RISC Criteria for lead is exceeded in unfiltered samples on more than one occasion in MW-2 and MW-7. With the exception of MW-3, each of the wells that exceed the IDEM Industrial Default RISC Criteria for arsenic or lead is located within or immediately adjacent to an area of the Site identified to contain some of the most deeply impacted soils.

MW-3 has had two total arsenic results at 11 ug/L, one total arsenic result at 28 ug/L and a result of 170 ug/L. The available filtered results for MW-3 have all been below 10 ug/L and field logs from the sampling event corresponding to the 170 ug/L (January 2007) result indicate that the turbidity of the sample was so high that the turbidity probe indicated an erroneous reading. Field parameters for all wells are also provided in Tables 1A through 1L. Recognizing that MW-3 was constructed in 1990, that the site soils have a naturally high arsenic content and that MW-3 is located in an area of the Site not associated with the recycling and smelting operations, the arsenic exceedances observed in MW-3 are believed to be a reflection of turbidity in the well and not water quality.

Although results of the groundwater sampling did not reveal site wide groundwater impacts, results did detect arsenic and lead above screening levels utilized for this project. Therefore, USEPA has requested that shallow groundwater be included as a component of the Corrective Measures for the site. The Constituents of Concern for groundwater are lead and arsenic. The selected remedy for groundwater is monitored natural attenuation (MNA). Section 5.5.2 and Attachment H provide a description of the groundwater sampling to be performed as part of the MNA.

5.0 STATEMENT OF BASIS

5.1 GENERAL

The results of soil and sediment sampling conducted as part of the RFI and site specific risk assessment performed during the CMS have determined that lead is present in soil and sediment on the site at concentrations that could represent an unacceptable risk to future occupants and therefore; require corrective measures. The RFI sampling conducted in off-site areas identified concentrations of lead in surface soil and sediment greater than the USEPA Regional Screening Level (RSL) for residential exposure to lead in soil and although a site specific risk assessment did not indicate a currently unacceptable risk within these areas, RMC has agreed to the USEPA's request to also perform corrective measures. Soil sampling performed as part of the Closure investigation also identified concentrations of lead and associated inorganic compounds in shallow subsurface soils beneath the pavement and floor slabs of the former indoor and outdoor waste piles. RMC must also close the storm water lagoon.

5.2 CORRECTIVE MEASURES

As stated above, the entire Site, except for those portions within the footprint of the HWMUs, is under the regulatory purview of the USEPA and was the subject of a Corrective Measures Study (CMS). The CMS included a human health risk assessment that evaluated specific non-residential exposure scenarios for the Site and proposed remediation alternatives for review and consideration by the USEPA. The Corrective Measures alternatives selected in the Statement of Basis issued by the USEPA are the excavation of soil above a Remedial Action Level (RAL) calculated to achieve an exposure area wide Preliminary Remediation Goal (PRG) and consolidation of the remediated soil in an on-site containment cell.

The soil PRG calculated by the risk assessment for the Site is 920 mg/kg. The risk assessment evaluated the Site as "Grassy" and "On-Site" exposure areas (Figure 2) and using the results of RFI and Closure sampling calculated RALs as follows:

- 4,954 mg/kg total lead in "grassy" areas; and,
- 8,470 mg/kg total lead in paved areas.

A deed restriction against future residential or other development inconsistent with the risk assessment exposure assumptions will be filed with the Site deed.

For soil and sediment in off-site areas accessible to the general public, RMC has agreed to perform excavation activities to a remediation level of 400 mg/kg total lead. Attainment of the proposed remediation concentrations will be based on post excavation sampling. The protocol for performing the sampling and interpreting the results is provided in the CQAP (Attachment D).

5.3 HWMU CLOSURE

The HWMU areas are RCRA Subtitle C Interim Status units. As stipulated in the Consent Decree, the HWMU areas are being closed under the regulatory purview of IDEM. RMC is proposing to perform the closure activities concurrent with the Corrective Measures and will be consolidating the remediated soils and sediment into the proposed on-site containment cell.

As documented in Advanced GeoServices Corporation's (AGC) September 24, 2008 letter to IDEM, it is RMC's intention to "clean close" the HWMUs. Based on the IDEM RISC Technical Guidance Industrial Default Closure Values, the target closure concentrations ("Standards") to be applied for the HWMUs are summarized as follows:

Parameter	Soil Standard	Groundwater Standard
Antimony	37 mg/kg	NA
Arsenic	20 mg/kg*	0.010 mg/L
Cadmium	77 mg/kg	NA
Lead	970 mg/kg**	0.042 mg/L
Selenium	53 mg/kg	NA

Notes:

*** The Soil Standard proposed for arsenic represents the "Direct Soil" value contained in RISC Industrial Closure Levels Table A (IDEM May 1, 2009). This value will be utilized over the default value of 5.8 mg/kg (based on Migration to Groundwater). Justification for use of the alternate value based on soil sampling which demonstrated a background arsenic concentration of 12.7 mg/kg and site specific SPLP testing which demonstrates an average partitioning coefficient more than an order of magnitude greater than the portioning coefficient utilized to calculate the default Migration to Groundwater value. This represents a modification of the value for arsenic proposed in the September 24, 2008 letter to IDEM.**

**** The Soil Standard proposed for lead represents the "Construction" value contained in RISC Industrial Closure Levels Table A (IDEM May 1, 2009). This value will be utilized over the default value of 230 mg/kg (based on Migration to Groundwater). Justification for use of the alternate value is based on site specific SPLP testing which demonstrates an average partitioning coefficient more than an order of magnitude greater than the portioning coefficient utilized to calculate the default Migration to Groundwater value.**

Standards are not shown for barium, chromium, mercury or silver, as these parameters were not indentified during Closure sampling at concentrations greater than the default Industrial Closure Levels for soil or groundwater, as established under the IDEM RISC Technical Guidance (Last Revised May 1, 2009). Standards for antimony, cadmium and selenium are limited to values for soil only as none of these constituents was detected at concentrations above the their respective default Industrial Closure Levels for groundwater, as established under the IDEM RISC Technical Guidance (Last Revised May 1, 2009).

Attainment of the proposed closure levels within the HWMUs will be based on post excavation sampling. The protocol for performing the sampling and interpreting the results will be based on procedures contained in the IDEM RISC Technical Guidance for default closure sampling (RISC Technical Guidance Section 6.3). The target potential exposure concentration (PEC) for the bottom of the excavations will be 970 mg/kg total lead. Specific information regarding the closure sampling are provided in the CQAP (Attachment D), but in general the intent is to demonstrate that the mean for the samples (collected randomly) representing a specific closure area is at or below the PEC.

5.4 CONTAINMENT CELL

Pursuant to the Statement of Basis issued by the USEPA, the containment cell will be situated in the northwest corner of the Site. The containment cell will be defined by a perimeter soil berm, have a soil bottom and be capped with a composite cap system. The composite cap will consist of (from top to bottom) a vegetative cover, erosion control mat, 6-inches of topsoil, 18 inches of compacted soil, double sided composite drainage net, 60 mil textured geomembrane and non-woven geotextile placed on a smooth, compacted soil subgrade. The drainage net will terminate in an anchor trench constructed in the perimeter soil berm. The anchor trench will contain a perforated pipe in a stone annulus designed to drain water from the drainage net to the surrounding ground surface.

Cover soil sliding and interface stability calculations have been performed and are provided in Attachment C. Those calculations have been performed for the "worst-case" slope condition based on the maximum cell grading (β = 33%, H=16 ft and L=48 ft) and an assumed minimum interface friction angles and soil unit weight (Φ=22° and σ =120 lb/ft^3). Collectively these values provide an interface factor of safety of 1.22. These are assumed values and must not be relied upon for final stability. As described in Specification Section 02751, interface friction testing ("shear box testing") must be performed utilizing the actual geosynthetic liner materials and cover soil fill proposed for use by the Contractor for cap construction. The shear box testing will be performed at confining pressures of 0.5, 1.5 and 3.0 psi for each interface (cover soil to geocomposite; geocomposite to textured geomembrane; textured geomembrane to geotextile; and geotextile to sub soil) and the result utilized to estimate the residual friction angles for each interface. If the results are less than 22°, the factor of safety will be less that 1.2 and the interface will be considered "unstable". If an unstable interface exists, RMC will have the option of requiring the Contractor to perform testing of alternate materials until acceptable interface friction values are achieved or modifying finished grading of the containment cell to attain the minimum required factor of safety.

As a result of the change in the containment cell location required by the Statement of Basis, sufficient space is available to allow an increase in the size of the cell foot print from approximately 1.15 acres to 1.44 acres (as measured at the anchor trench). At the maximum 3:1 grading shown on Sheet 5, cell capacity will be approximately 25,679 cubic yards; sufficient volume to accommodate all of the soil and sediment currently proposed for remediation as part of the Corrective Measures and HWMU Closure and still provide additional excess capacity for soils from the Citizens Gas property and/or additional material generated on-site as a result of additional excavation performed within area of failing confirmatory sampling results. In the event the additional airspace it not required, the larger footprint will allow the finished containment cell to have a lower profile cap than the maximum configuration shown on Sheet 5. If insufficient air space is available to accommodate all remediated soil and sediment, excess materials will be sent for off-site disposal. Sheet 5 also shows the completed cap with the minimum required finished cap slope of 3%. The associated volume for the minimum grading is <6,000 cy.

5.5 GROUNDWATER

Groundwater sampling conducted as part of the RFI has identified concentrations of arsenic in the shallow perched groundwater above 10 ug/L on more than one occasion in MW-1, MW-2, MW-3, MW-7, MW-8 and MW-10; and lead concentrations above 42 ug/L on more than one occasion in MW-2, and MW-7. The Statement of Basis issued by the USEPA, requires RMC place a deed restriction on the property against the use of groundwater from the Site as a potable water source. The Statement of Basis also selected Monitored Natural Attenuation (MNA) as the approach to restoring groundwater quality. MNA is predicated on an improvement of groundwater quality following completion of the proposed soil remediation activities. In addition, RMC must install and sample a system of groundwater monitoring wells capable of monitoring groundwater quality in the vicinity of the containment cell for indications of groundwater degradation.

5.5.1 Containment Cell Groundwater Monitoring

During the initial stages of Corrective Measures implementation, RMC will have groundwater monitoring wells MW-7 and MW-10 and the former facility production well abandoned. Permanent abandonment shall be in accordance with the requirements established in 312 Indiana Administrative Code 13-10 (Rule 10). Rule 10 requires that abandonment activities be performed by a water well driller using a neat cement, bentonite slurry, or crushed or pelletized bentonite. Notification of abandonment will be filed by the well driller within 30 days following completion of plugging activities.

Immediately following construction of the containment cell perimeter access road, RMC will install six new shallow wells to monitor groundwater quality in the shallow perched zone beneath and in the general vicinity of the proposed containment cell. The proposed well locations, labeled as CC-1 through CC-6, are identified on Sheet 4 of the design drawings. The well locations were selected to encompass the Containment Cell to monitor groundwater quality for indications of groundwater degradation. The new wells and remaining existing wells will be surveyed by a professional surveyor retained by RMC to ensure all groundwater measurements are utilizing the same vertical and horizontal datum. The containment cell monitoring wells (CC-1 through CC-6 and MW-2) will be subject to at least one round of groundwater sampling prior to and/or coincident with corrective measures construction and then routine monitoring following completion of corrective measures construction as part of long term Operation and Maintenance activities.

5.5.2 MNA Groundwater Monitoring

The area of site groundwater that is the subject of MNA was determined based on the results of previous groundwater sampling, the hydrogeologic conceptual site model, and an understanding of the operating history of the facility. The groundwater monitoring wells to be included as part of the MNA groundwater monitoring network will consist of MW-1, MW-2, MW-3, MW-8, MW-9, MW-12, and CC-1 through CC-6. These wells have been selected as they bound the MNA monitoring zone. Existing wells MW-7 and MW-10 are not included as part of the proposed MNA sampling network because they are located in the prepared containment cell location and are proposed for abandonment as part of the proposed corrective measures. As summarized in Section 4, groundwater sampling has identified concentrations of arsenic > 10 ug/L in MW-1, MW-2, MW-3, MW-7, MW-8 and MW-10; and concentrations of lead >42 ug/L in MW-2 and 7. Pursuant to the Statement of Basis, RMC will conduct sampling at the designated wells for the purpose of determining if concentrations are increasing, decreasing or stable, and to collect data regarding groundwater parameters that directly impact groundwater geochemistry.

The MNA groundwater monitoring wells will be sampled beginning approximately one month following installation of the proposed containment cell monitoring wells. Sampling will be performed once every calendar quarter for twelve consecutive quarters with the first evaluation regarding future frequency performed after completion of the second year of monitoring (i.e., after 8 quarters). Monitoring will end when the sampling results demonstrate that the remedial goals have been attained for four consecutive quarters. During the first two quarterly groundwater sampling events, samples will be analyzed for total and dissolved arsenic and lead, sulfide, sulfate, nitrate arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), and manganese speciation (MnII/MnVII) for use in geochemical modeling. Beginning after the second quarterly groundwater sampling event, groundwater analysis will be limited to total and dissolved lead and arsenic. Field parameter readings to be recorded at the time of sample collection during all groundwater sampling events shall include temperature; pH; Eh; dissolved oxygen (DO); specific conductance and turbidity.

Detailed information regarding the proposed MNA activities is provided in the MNA Work Plan (Attachment H).

6.0 DESIGN ELEMENTS

6.1 PREPLANNING, PERMITTING, AND ACCESS

The selected Contractor will be required to provide a detailed construction schedule presenting his proposed approach to the project. The schedule, with appropriate backup information, will reflect the Contractor's approach to the project including the anticipated sequence of construction, estimated times for completion, assumed production rates, critical path and milestones. The schedule will also demonstrate their understanding of intrinsic design elements. The construction schedule will not be subject to regulatory approval, except to the extent the Contractor's approach or sequence may significantly deviate from the CMD as currently proposed. Acceptance of the schedule by RMC will not be considered approval of a variance from the CMD or other requirements of the Contract unless specifically approved in writing by RMC. Copies of the schedule will be provided to the USEPA and IDEM prior to the start of work.

A pre-construction meeting between representatives from RMC, the Contractor, owners of property which will be remediated, and the appropriate Agencies will be held at the Site prior to the onset of active remedial activities. During the pre-construction meeting, the Contractor will present his approach to the project including schedule and sequence of work and address questions and concerns.

Remedial activities will not begin until the necessary permits are granted and required Notice of Intent (NOI) letters (erosion and sediment control) have been submitted to and approved by IDEM. A list of the required permits has been identified and is included in Section 7.0.

Access to off-site areas requiring remediation will be secured prior to the onset of corrective measures. Amtrak and CSX were contacted during preparation of the Pre-Final Design to determine limitations and restriction associated with excavation or construction activity within railroad right-of-ways and to discuss any additional considerations regarding work in close proximity to their tracks. Through those contacts, it was confirmed that CSX is the owner of the right-of-way for the tracks north of the site and Citizens Gas; however; information received from Amtrak indicates that they do not own the tracks between Big Four Road and the Citizens Gas fence. A review of the Marion County Indiana Tax Assessors office determined that the property between the southern fence for Citizens' Gas and Big Four Road is owned by Citizens Gas.

Relative to work in the CSX right-of-way, RMC is providing additional design details for their review. The proposed excavation is a minimum of 25 feet from the closest rail and the depth of proposed removal are outside the "theoretical railroad embankment line" (a 1:1.5 line that extends out and down from a point located 12 feet from the centerline of the track) that would require sheeting and shoring. Requirements for the access by equipment and personnel between the tracks and proposed excavation will also require that the Contractor carry specific railroad insurance and have a CSX approved flagman present during the work to control access and train traffic. To protect the track on the property owned by Citizens Gas, no excavation will be performed within the theoretical railroad embankment line. The theoretical railroad embankment line has been plotted on excavation cross-sections provided on Sheet 12.

Work within the right-of-way of South Arlington Avenue will require that the Contractor obtain a right-of-way permit. Typically these would be issued through the City of Beech Grove but because South Arlington Avenue is identified as a "primary arterial road" additional approval from the City of Indianapolis may be necessary.

6.2 SITE PREPARATION, DUST CONTROL AND STORM WATER MANAGEMENT DURING CONSTRUCTION

Site preparation activities will include establishment of the support zone, installation of erosion control measures, implementation of dust control measures and air monitoring, mobilization and activation of temporary water treatment equipment and utility location and abandonment, as needed. Exclusion and contaminate reduction zones will be designated to mitigate cross contamination. Equipment and personnel decontamination stations will be instituted to minimize the potential of contaminant release. Traffic routes and access will be established for transport of contaminated materials between excavation areas and the containment cell.

Clearing and grubbing of the containment cell location and other excavation areas within the northern wooded area will be required to facilitate equipment access. Roadways will need to be established for material transport. These areas will require grading such that erosion and sediment control is maintained.

Dust control measures will be selected by the Contractor based on the means and methods proposed for completion of the project. In general, these are expected to include the use of water to wet the ground surface and areas of excavation. During decontamination and demolition activities the contractor mobilized large spray-misters that utilized fans and water spray to wet the work zone in the surrounding area and to help suppress dust. The contractor also utilized a water truck on a nearly continuous basis during dry weather to keep site pavement wet. Section 02115 of the Specifications provides additional information related to dust control and Section 02999 provides requirements for dust control and air monitoring.

Storm water management and erosion controls will be performed in accordance with applicable standards and practices as set forth in the Indiana Storm Water Quality Manual and the Indianapolis Storm Water Design and Construction Specifications Manual. Storm water during construction activities can be characterized as follows: storm water runoff from areas of exposed soils and sediment requiring remediation (i.e., active excavations) and storm water runoff from areas not designated for remediation or where remediation is already completed (i.e. "clean areas").

Storm water associated with active excavations, and decontamination water, will require collection and treatment prior to discharge to the POTW through the existing sanitary sewer. Collected water requiring treatment at a minimum will be processed through a series of bag filters. The Contractor will determine the exact configuration and filtration requirements necessary to meet the discharge requirements established by the POTW and determine if additional treatment is necessary. Storm water and decontamination water will be treated in batches and stored in tanks until approved for discharge by the Engineer based on analytical results representing the treated batch. To the extent possible, the Contractor will utilize treated water for dust control purposes in an attempt to reduce the volume of water discharged to the POTW. The maximum batch size shall be 30,000 gallons. The maximum discharge rate to the POTW will be 90 gallons per minute or as otherwise dictated under the Special Discharge Permit. The limits for discharge of water to the POTW will be established under the Special Discharge Permit and therefore the exact parameters and values can not be determined at this time. However, for comparison purposes the following parameters and limits were required for the decontamination and demolition activities:

- pH 5.0 to 12.0 S.U.
- Arsenic 4.0 mg/L
- Lead 4.7 mg/L
- Zinc 36.0 mg/L
- TPH 200 mg/L

Storm water from the clean areas will not require collection and management, except to the extent required to control erosion, avoid entry into active excavations and work zones, and prevent uncontrolled runoff to adjacent property. The Contractor will utilize the existing pump and piping system to convey clean storm water runoff from the existing sump areas to the drainage ditch along the CSX right-of-way. The Contractor will sequence his work to ensure the four pump houses will remain in operation as long as possible during construction or he will establish new temporary pumping to continue water management. During excavation and restoration activities in the CSX drainage ditch, the Contractor will be required convey the storm water to a location down stream from the disturbed section of the drainage ditch.

The lagoon will cease to be used for storm water management when closure of the lagoon begins. The current paved surfaces at the Site have been cleaned as part of the decontamination and demolition project and the associated storm water runoff is approved for discharge without treatment. If an area contributing runoff to one of the pump houses or collection area established by the Contractor becomes re-contaminated, the Contractor will be required to analyze the accumulated water from that pump house and demonstrate the water still meets the appropriate discharge criteria. If the water does not meet the discharge criteria the Contractor will be required to collect and treat all storm water flowing to that pump house.

Storm water from the "grassy" areas, will continue to be managed by utilizing existing drainage features such as the perimeter swales. The construction within the grassy areas and swales will be sequenced such that remediation in the upslope areas is completed before down slope areas. This will help prevent recontamination. The design requires restoration of remediated swales using either grass sod or geotextile and stone each of which allows immediate re-stabilization of the remediated areas.

6.3 CONTAINMENT CELL CONSTRUCTION

The containment cell will be situated in the northwest corner of the Site, as shown on Sheet 5 of the design drawings. The containment cell will be 330 feet long by 190 feet wide defined by the centerline of an 8 feet wide earthen berm. The berm will have a top of berm elevation of 843.0 and an interior bottom elevation of 841.5. Perimeter drainage features will convey stormwater runoff to the proposed stormwater management basin.

A review of potentiometric groundwater levels collected at MW-10 since installation in 2003 shows the groundwater elevation within the vicinity of the proposed containment cell have varied between 833.24 (October 2007) and 841.25 (April 2005) standing water has been noted in the vicinity of MW-10 after precipitation events. Based on a direct comparison, this means the groundwater has ranged from 8.26 feet below to 0.25 feet below the proposed cell bottom elevation. Following completion of proposed grading and drainage features, the minimum vertical separation is expected to be at least 1.0 feet based on a maximum possible surface water elevation in the stormwater basin of 840.5. In addition, the impermeable barrier created by the cap essentially eliminates infiltration beneath the cap footprint.

Proposed finished grades will be no steeper than 3 horizontal to 1 vertical (33%) and no flatter than 33 horizontal to 1 vertical (3%). The maximum proposed elevation of the top of cap will be 862.5 +/-. The maximum grading shown on Sheet 5 of the design drawings for the top of waste and top of cap represents the maximum filling configuration and provides a waste disposal capacity of approximately 25,679 cubic yards. The total combined volume of soil, sediment and miscellaneous debris to be excavated is approximately 18,000 cubic yards. This includes approximately 5,000 cy of soil from the HWMUs, approximately 6,000 cy of soil from other on-site areas, approximately 5,000 cy of on-site debris and approximately 2,000 cy of off-site soil and sediment (excluding material from Citizens Gas).

The containment cell berm will be located 50 feet from the northern and western property boundaries as measured from the centerline of the proposed berm. The area between the berm and property line will be utilized to accommodate a perimeter access road and swale. The access road will provide access for sampling the proposed groundwater monitoring wells and maintaining the swale. The swale will collect runoff from the west and north sections of the containment cell cap and convey it into the outlet structure for main storm water management basin. The remainder of the cap and storm water from the majority of the former manufacturing area will drain directly to the storm water management basin located east of the cell. The invert elevation of the lowest outlet device for the basin will be 837.25; during periods of higher groundwater, the basin may also convey some groundwater.

Construction of the cell will require minor cutting and filling to create the swale, berm and access road. Existing groundwater monitoring wells MW-7 and MW-10 will be abandoned by RMC prior to the start of Corrective Measures construction. Permanent abandonment of groundwater monitoring wells MW-7 and MW-10, and permanent abandonment of the former facility production well (located near the former warehouse) shall be in accordance with the requirements established in 312 Indiana Administrative Code 13-10 (Rule 10). Rule 10 requires that abandonment activities be performed by a water well driller using a neat cement, bentonite slurry, or crushed or pelletized bentonite. Notification of abandonment will be filed by the well driller within 30 days following completion of plugging activities.

Existing trees will need to be cleared and grubbed from the proposed containment cell and storm water management basin area. Cleared and grubbed material (trees and shrubs) will be sent off-site for disposal. Excavation areas NW and ND1 will be dug to the vertical and horizontal limits shown on Sheet 7 and the resulting spoils (approximately 1,000 CY) stockpiled to await placement in the containment cell. After completion of remediation in NW and ND1 the topsoil will be stripped from the remaining area and placed in 500 cy (maximum) stockpiles. The volume of topsoil to be stripped is uncertain, but assuming an average thickness of 8-12 inches, is expected to be on the order of 3,000 to 5,000 cy.

After removal of the topsoil, cutting and filling of native soils will be performed to achieve the design grades necessary to define the perimeter access road, swale, containment cell and storm water management basin. No confirmatory sampling is required prior to commencement of cutting and filling except as required within excavation areas NW and ND1. Depending on the average thickness of topsoil removed it may be necessary to import structural soil fill (Specification Section 02210) to complete the required grading. If excess native soils remain after completion of required grading excess materials shall be stockpiled (500 cy max) and characterized to determine the acceptability for use as backfill elsewhere on-site.

General procedures for stockpile sampling are provided in the Sampling and Analysis Plan portion of the Construction Quality Assurance Plan (Attachment D). Stockpile samples will be analyzed for lead, arsenic, antimony, cadmium and selenium (Method 6010). Analytical results for arsenic, antimony, cadmium and selenium will be compared against the soil standards listed for HWMU Closure in Section 5.3 of the CM Design Report. Lead will be compared against the 920 mg/kg PRG calculated by the BHHRA and the 400 mg/kg residential soil screening value being used for lead in soil within the public and railroad right of way. Stockpiles with results below the HWMU soil standards for arsenic, antimony, cadmium and selenium and less than 400 mg/kg lead can be utilized as backfill anywhere on-site. Stockpiles with results below the HWMU soil standards for arsenic, antimony, cadmium and selenium and between 400 mg/kg and 920 mg/kg total lead can be utilized as backfill anywhere on-site except within drainage features and the storm water management basin. Stockpiles with results that exceed the HWMU soil standards for arsenic, antimony, cadmium and selenium or have >920 mg/kg lead will be placed in the containment cell or sent off-site for disposal.

Containment cell filling will be performed in lifts. Lifts will have a maximum loose lift thickness of 18-inches and each lift will be compacted until visually stable as determined by the QA Representative. Filling will be sequenced to contain storm water runoff from the exposed waste surface and the contractor will be required to collect and treat standing water prior to placement of subsequent lifts. Access into the cell will be provided from the south end and equipment entering the cell and running across areas of exposed soil will be required to clean the wheels before exiting the cell. The Contractor is encouraged to utilized designated equipment in the cell and dump materials destined for the cell without actually entering the cell.

6.4 HAZARDOUS WASTE MANAGEMENT UNIT CLOSURE

6.4.1 Surface Impoundment

The surface impoundment (lagoon) is an Interim Status RCRA Hazardous Waste Management Unit (HWMU) that is subject to the Closure requirements contained in 40 CFR 265.228. The Contractor will remove standing water in the lagoon. The Contractor may elect to transfer the water directly to holding tanks for testing or process the water through the temporary water treatment system prior to placement in the tanks and testing. The accumulated sediment and vegetation will be removed and placed in the on-site containment cell. Throughout sediment removal the Contractor will continue to collect and manage water draining from the sediment. After removal of liquid, bulk sediment, vegetation, the liner and miscellaneous debris, the Contractor will demolish the concrete component of the liner. Demolition of the concrete liner will be performed from the perimeter of the lagoon and work inwards taking care to minimize disturbance to the subsoils.

Cement concrete (including masonry) will be crushed to the gradation requirements for Granular Fill specified in Specification Section 02210 or Surface Stone specified in Section 02936, separated into stockpiles (not exceeding 500 cubic yards each) and sampled (see stockpile sampling requirements in the Sampling and Analysis Plan portion of the Construction Quality Assurance Plan (Attachment D)). To determine the acceptability of the material for use as fill the samples will be analyzed for lead, arsenic, antimony, cadmium and selenium (Method 6010). Analytical results for arsenic, antimony, cadmium and selenium will be compared against the soil standards listed for HWMU Closure in Section 5.3 of the CM Design Report. Lead results will be compared against the 920 mg/kg PRG derived by the BHHRA and the 400 mg/kg residential soil screening value being used for lead in soil within the public and railroad right of ways. Crushed concrete and masonry stockpiles with results below the HWMU soil standards for arsenic, antimony, cadmium and selenium and less than 400 mg/kg lead can be utilized as Granular Fill or Surface Stone anywhere on-site. Crushed concrete with results below the HWMU soil standards for arsenic, antimony, cadmium and selenium and between 400 mg/kg and 920 mg/kg total lead can be utilized as Granular Fill anywhere on-site except within the drainage features or the storm water management basin. Stockpiles with results that exceed the HWMU soil standards for arsenic, antimony, cadmium and selenium and/or with >970 mg/kg lead will be placed in the containment cell or sent off-site for disposal. Crushed concrete sent for placement in the containment cell may not be placed within 12-inches of the final top of waste unless crushed to a maximum particle size <1.5 inches.

Previous sampling of soil beneath the concrete liner produced results that were all below the action levels being applied to closure of the HWMUs except for a single sample (CSB-37 A (0-3 inches)) which had an arsenic concentration of 25 mg/kg. This result is only slightly above the action level for arsenic of 20 mg/kg and in consideration of the associated lead result of 58 mg/kg, is believed to be a reflection of variability in background arsenic concentrations rather than impacts from former facility operations. Therefore, no soil remediation is proposed within the footprint of the lagoon. The Engineer will collect soil samples from the soil immediately beneath the concrete following the procedures established in the CQAP for confirmatory sampling at the bottom of excavations. The results will be evaluated as confirmatory samples against the soil standards established for the HWMUs in Section 5.3 of the CM Design Report.

6.4.2 Former Waste Pile Locations

Those areas of the Site horizontally utilized for the management of feed materials for the recycling operation and resulting solid waste materials were designated as waste piles in the facility Part A filing and granted interim status under RCRA. The waste pile areas were subject to focused sampling as part of the Closure Investigation and were also subject to a limited amount of additional sampling as part of the site wide RCRA investigation. The locations and results of the borings are provided on Sheets 2 and 3 of the design drawings, respectively. Additional discussions of the design elements for the former waste piles are provided separately below based on those that were indoors and those that were outdoors.

6.4.2.1 **Outdoor Waste Piles**

The Outdoor Waste Piles consist of six separate areas (number 1 through 6) as shown on Sheet 1 of the design drawings. The total combined area of the Outdoor Waste Piles is approximately 1.8 acres. Records indicate that the outdoor waste piles were originally utilized to store lead bearing materials waiting processing recycling and waste products (primarily slag) awaiting off-site disposal. The existing ground surface of the outdoor waste piles is characterized by bituminous concrete (asphalt) or Portland cement concrete pavement. The only remnant structures within the footprint of the Outdoor Waste Piles are two former equipment pedestals in area 1 (near the northwest corner of the Material Storage Building (MSB)) and Area 5, the former loading dock of the MSB. During the recent facility demolition, all paved site surfaces were cleaned to remove debris and sediment.

Thirty-one soil borings were conducted within the footprint of the Outdoor Waste Piles as part of the Closure Investigation plus seven borings performed as part of the RFI. To meet the closure criteria established for the HWMUs, soil remediation will be required at the areas depicted on Sheet 6 of the design drawings. As shown, excavation depths range from no removal to 7.25 feet, as measured from the existing ground surface.

Closure of the Outdoor Waste Piles will consist of removing the pavement covering the area to be remediated taking care to segregate the concrete pavement (including curb) from the asphalt pavement and separating the pavement from the subbase materials. After removal of the pavement, the Contractor will selectively excavate the underlying soil to the target removal depths. Spot elevations will be obtained at designated locations on the existing ground surface, prior to removal of the pavement and utilized as control points to guide the depth of excavation activities. The segregated asphalt pavement and excavated soil will be sent directly to the containment cell, placed in lifts and compacted to provide a stable surface. The segregated concrete will be crushed, placed in stockpiles (500 cy max.) and characterized for possible reuse as granular fill. Remnant concrete structures or foundations that may be encountered during excavation activities will be cleaned using hand tools to remove soil before being sent for crushing.

To document attainment of soil standards applicable to the HWMU Closure, post-excavation confirmatory sampling will be performed at the bottom of the excavations and along the side walls that are inside the footprint of the HWMUs. Sidewall sampling will not be performed on sidewalls that coincide with the horizontal limits of the HWMUs. Adequacy of sampling outside the limits of the HWMUs will be determined based on post-excavation confirmatory sampling requirements for on-site corrective measures described in Section 6.5. Post-excavation sampling will be performed in accordance with the procedures established in the Construction Quality Assurance Plan (Attachment D).

Following approval of confirmatory sampling information by the QA Representative, the resulting excavation will be backfilled with granular fill or structural soil fill to the proposed finished grades. Materials utilized for backfill within the limits of the Outdoor Waste Piles shall meet the remediation requirements for the HWMUs. The Contractor will protect the remediated area against cross contamination from surrounding areas.

6.4.2.2 **Indoor Waste Piles (Material Storage Building)**

The indoor waste piles were located in the Material Storage Building (MSB). The MSB was located at the north end of the main building (see Sheet 1). The MSB was approximately 165 feet by 165 feet with an enclosed corridor into the adjacent Furnace Room. The interior of the MSB included multiple bins used to store lead battery components awaiting processing through the furnace and various other raw materials (such as coke, iron and limestone or crushed concrete) also used in the smelting process. The MSB had concrete floors (typically 6 to 8 inches thick) sloped to drain from the exterior walls inward. During the various investigation activities, the concrete floor was observed to be degraded in the north central portion of the building, presumably a result of the acid in the lead battery feed material reacting with the concrete. The areas of greatest degradation coincide with the areas of proposed deepest excavations as shown on Sheet 6 of the design drawings.

As part of the recently completed decontamination and demolition activities, the 4 to 5 feet high concrete walls forming the exterior of the building and defining the interior bins were demolished to grade. The floor was filled with up to 18 inches of concrete rubble from other areas of the site that had been cleaned and crushed and then covered with a 20 mil PVC geomembrane. The crushed concrete was placed to create positive drainage for precipitation falling on the PVC geomembrane to the storm water collection system. The geomembrane is protected against wind uplift by approximately 300 to 400 sand bags. An estimated 500 to 600 cubic yards of crushed concrete rubble were placed over the MSB floor.

Closure of the indoor waste pile is expected to be one of the initial remedial activities to be performed after preparation of the disposal cell. Closure will consist of removing the PVC geomembrane and excavation of the crushed concrete rubble; removal of the concrete floor and excavation of underlying soils to the depths specified on Sheet 6 of the design drawings. The removal of the geomembrane, crushed concrete rubble and concrete floor will be performed in sections of a size to be determined by the Contractor based on his means and methods for construction. The geomembrane will be cut into sections no larger than 30 feet by 30 feet and placed flat (panels may be folded but not crumpled) in the bottom of the containment cell. The crushed concrete rubble and debris resulting from removal of the floor will be placed in the Containment Cell in loose lifts not to exceed 18-inches thick. Each lift will be compacted to provide a stable surface before the placement of subsequent lifts.

"Soil" removal within the MSB will be to a minimum depth of 12-inch (as measured from the top of the concrete pad) over the entire MSB footprint with specific areas as shown on Sheet 6 of the design drawings to depths as great as 72-inches. The total estimated removal volume within the MSB (excluding the rubble placed during decontamination and demolition) will be approximately 1,400 cubic yards (cy); including 700 cy of concrete representing the floor and 700 cy of soil and crushed aggregate excavated from beneath the concrete floor. The Contractor will be required to obtain spot elevations from the top of the concrete floor prior to removal for use in controlling depth of excavation. Confirmatory sampling will be performed at the bottom of the excavations and along side walls that are inside the footprint of the HWMUs to document attainment of closure criteria. Sidewall sampling will not be performed along sidewalls that coincide with the boundaries of the HWMUs where the exterior boundaries are not adjacent to other HWMUs.

Following approval of confirmatory sampling information by the Engineer, the resulting excavation will be backfilled with crushed stone or soil to the proposed finished grades. Backfill materials generated on-site and utilized for backfill within the limits of the MSB and other HWMUs shall meet the HWMU remediation criteria. Imported backfill material shall meet the IDEM RISC Residential Default Criteria. The Contractor will protect the remediated area against cross contamination from surrounding areas.

6.5 ON-SITE CORRECTIVE MEASURES

On-site corrective measures pertain to non-HWMU soil and "sediment" in the excavation areas located within RMC property boundaries as presented in Sheet 7 of the design drawings, excluding excavation within public and railroad right-of-ways. Non-HWMU soil excavation areas included the former manufacturing area (referred to as "On-Site Manufacturing Area" in the BHHRA), and lawn and wooded area (referred to "Grassy Area" in the BHHRA) of the Site that are outside of the HWMUs which exceed the calculated RALs of 8,470 and 4,954 mg/kg total lead, respectively. Although referred to as "sediment", the non-HWMU sediment excavation areas are generally mowed lawn on the site and small shallow storm water ditches with little or no actual sediment present in these features and the samples designated as "sediment" were most typically soil.

6.5.1 Soil Excavation

Excavation of on-site soils will require the removal of overlying floors and pavement in areas where subsoils exceed the RAL. Floors and pavement will be removed in a manner that minimizes disturbance of underlying soils. The concrete will be segregated from asphalt pavement and from the underlying subbase materials, crushed, stockpiled and sampled for potential use as excavation backfill. Sampling will be required to determine if the rubble meets backfill standards (see Specification Section 02210). Any rubble that does not meet the

Specifications will be placed in the containment cell or sent off-site for disposal. The areas of floor and pavement to be removed will be limited to only those areas requiring removal of subsoils. The Contractor shall provide sufficient dust control measures to ensure that the requirements for dust control identified in the Specifications and CQAP are met.

Soil excavation activities will be performed using commonly available construction techniques and readily available equipment and qualified labor. As required by the Specifications, the Contractor shall utilize appropriately placed silt fence, construction sequencing, storm water diversion and similar techniques to protect against erosion and transport potentially contaminated sediment from the site.

The Contractor will be required to develop specific measures to minimize the potential release of contaminants during excavation and exposure of on-site workers and off-site individuals in the immediate vicinity of the Site. Engineering controls such as staged construction, water misting for dust suppression, and proper use of personal protective equipment will be employed to mitigate exposures and potential releases during excavation.

6.5.2 Sediment Excavation

Excavation will be performed within the northern drainage ditches and the driveway ditch to remove "sediment" exceeding 400 mg/kg total lead. (As stated above, the drainage swales are generally mowed lawn on the site and small shallow storm water ditches along the CSX railroad tracks). Little or no actual sediment was present in these features. The samples were designated as "sediment" because they came from the bottom of the drainage swale, not because they represented significant bed load in the drainage ditch.

The northern drainage ditches are located along either side of the abandoned RMC railroad spur in the wooded area to the north. Historic activities are assumed to have conveyed surface water from the Site to the drainage ditches, depositing lead impacted solids along their span. The drainage ditches continue to receive storm water from the Site and flow north toward the CSX railroad line to the north. Three check dams consisting of geotextile and stone are located along the ditches. The check dams trap sediment upstream under current flow conditions and allow the passage of storm water downstream. Excavation in this area includes removal of the check dams within the lateral extents of the ditches. The stone, geotextile and accumulated sediment within the check dam will be placed in the containment cell with the remediated sediment/soil. The drainage ditches are located within a heavily wooded area and will require clearing to facilitate equipment access. Excavation to a depth of 12 inches and extending 5 feet on either side of the centerline of the ditches is expected to achieve sufficient remediation. Sediment excavation may require dewatering of the ditches and water removed during excavation will require testing prior to discharge or diversion. Sediment control measures may be required to reduce the potential for further contaminant migration during excavation.

The driveway ditch is located along the northern side of the main entrance to the Site, off of South Arlington Avenue. Boundaries of the ditch are fairly well defined in areas, and the area of proposed excavation is intended to include the ditch and the adjacent lawn area. The area continues to receive surface drainage and removal of standing water may be required prior to or during the course of excavation. Water removed during excavation will require treatment prior to discharge. Sediment control measures may be required to reduce the potential for contaminant migration during excavation.

Excavation in these areas will be performed using commonly available construction techniques and readily available equipment and qualified labor. The Contractor shall implement Best Management Practices (BMPs) during and after excavation activities to prevent erosion.

6.6 OFF-SITE CORRECTIVE MEASURES

Off-site corrective measures are presented in Sheets 7 and 8 of the design drawings and pertain to proposed excavation areas: within the mowed lawn drainage ditch along South Arlington Avenue, mowed lawn section of the Citzens Gas property between Big Four Road and Citizens Gas fence line; within portions of the northern drainage ditch outside of the RMC property boundary along the CSX right-of-way; and on the Citizens Gas property.

6.6.1 Remediation in Public Right-of-Ways

As shown on Sheet 7, approximately 1,500 feet of the mowed lawn drainage feature along South Arlington Avenue will require excavation of soil/sediment exceeding the USEPA residential screening level of 400 mg/kg lead in soil. Excavation will extend from the edge of pavement to the RMC fence line at varying depths of 6 to 18 inches, with depths generally increasing from north to south. Excavations along the South Arlington Avenue pavement deeper than 6 inches will be stepped in 6-inch increments to avoid damage or undercutting of the road way.

Remedial activities along South Arlington Avenue will involve use of the roadway for equipment access and material transport. As identified in this Design Report, a Right-of-Way permit will be required for this work. Under such permit, traffic control measures shall be implemented by the Contractor in accordance with the Indiana Manual of Uniform Traffic Control Devices. At a minimum, traffic control devices shall be installed prior to commencement of operations, be properly maintained and utilized during excavation and restoration activities, and be removed immediately upon completion. Careful consideration of excavation approaches will need to be exercised in this area due to the presence of overhead and subsurface utilities.

Careful planning with regard to weather forecasts and incorporation of erosion control techniques will be essential as this area receives considerable surface drainage.

6.6.2 Remediation Within Railroad Right-of-Ways

As shown in Sheets 7 and 8, remediation within the active railroad right-of-way includes excavation along the CSX line north of the Site. Excavation in the former right-of-way along Big Four Road, represents property owned by Citizens Gas and the track is inactive except for sporadic use by the adjacent Amtrak facility.

Remediation in the CSX railroad right-of-way consists of removal of sediment exceeding 400 mg/kg total lead within the drainage ditch paralleling the tracks, extending approximately 600 feet west of the northwest corner of the RMC property. Excavation in this area will necessitate proper identification of utility locations prior to commencement. Postings indicate that a Fiber Optics line is located along the tree line in this area. Excavation will be performed using conventional construction equipment. Dewatering of the swale and inclusion of sediment control methods may be necessary to facilitate excavation. Due to the geography of the area and close proximity to the tree line, additional clearing may be necessary to access for excavation. Access may best be achieved from the containment cell location.

6.6.3 Citizens Gas Property

Citizens Energy Group (Citizens) will record deed restriction for the Citizens property immediately adjacent to the west side of the site. The deed restriction will be recorded after RMC completes certain work agreed upon by Citizens on the Citizens property. The work is to be performed simultaneously with Corrective Measures Implementation at the site. The deed restriction shall prohibit the use of the Citizens property for any residential purpose including, but not limited to, residences, hotels or motels, hospitals or in-patient medical care, playgrounds or recreational facilities, or daily care facilities (e.g., day care centers, schools, senior citizen facilities, nursing homes, or assisted living facilities). Prior to filing the deed restriction, RMC and Citizens will ensure that the wording of the deed restriction is acceptable to both EPA and IDEM.

6.7 CONTAINMENT CELL CAPPING AND CLOSURE

The final grading of the cap will be dictated by the actual volume of soil, sediment and debris placed, and the results of interface friction testing for the selected cap geosynthetic and soil materials, but the maximum grading will not exceed that shown on Sheet 5 of the design drawings. Maximum slopes will be 33%. As filling progresses to elevations above the top of berm, the Contractor will be required to place temporary diversions to intercept storm water runoff from the exposed materials in the cell and convey that water to the temporary treatment system for processing. When final grades are reached, the finished surface will be smooth graded, rolled and protruding rocks or other objects that could puncture the geomembrane will be remove by the Contractor. Following approval of the finished surface by the QA Representative, the Contractor will be required to protect the area against vehicular traffic except to the extent necessary to deploy the liner components. Any damage to the approved surface will be repaired by the Contractor to the satisfaction of the QA Representative prior to geomembrane placement. The approved surface may be temporarily covered with plastic sheeting or non-woven geotextile until mobilization of the liner installer, provided such measures protect the surface against erosion. Any such temporary cover must be adequately balanced to protect against disturbance by wind or other causes.

The proposed cap will be a non-woven geotextile placed directly on the approved soil surface, a textured 60 mil HDPE geomembrane (Cap Barrier Layer); double sided drainage net (Cap Drainage Layer); 18-inches of compacted soil fill; 6-inches of topsoil; erosion control mat; and vegetative cover. The geomembrane and drainage net components of the cap will terminate in an anchor trench in the top of the berm. Infiltrating precipitation intercepted by the drainage net will be collect in a perforated pipe situated within the anchor trench. The perforated pipe will have outfalls periodically around the perimeter of the berm to discharge collected water. Specification Section 02751 provides requirements the Cap Drainage Layer; and Section 02755 provides requirements for the Cap Barrier Layer.

6.8 BACKFILL AND RESTORATION

6.8.1 Site Security Fence

During containment cell construction activities, the Contractor will be required to erect permanent site security fence along the common property boundary with the CSX right-of-way along the northern boundary of the site. The new fence will begin at the existing corner post for the Citizens Gas security fence and terminate at the existing corner post for the RMC fence along South Arlington Avenue. Actual alignment along the CSX right-of-way will be established based on property line survey to be completed by the Contractor's surveyor. Warning Signs shall be posted along the alignment of the perimeter security fence (new and old) as described in Specification Section 02831.

Additional security fence repairs and/or replacement will be made as required by RMC or required to facilitate proposed construction activities.

6.8.2 Containment Cell Exterior Berms, Drainage Swale and Access Road

The anticipated sequence of construction will result in the exterior berms, access road and drainage features being constructed prior to the start of site-wide and off-site remediation activities. The centerline of the 12 feet wide perimeter access road on the north and east sides of the containment cell will be located 10.5 feet from the western (common property line with

Citizens Gas) and northern property boundary (CSX right-of-way) as field located by the Contractor's surveyor. The access road and drainage swale will be constructed through cutting and filling with structural soil fill following the procedures provided in Specification Section 02210, to achieve a completed stable subgrade surface. The proposed culvert leading from the drainage swale into the storm water management basin outlet structure shall be installed (Specification Section 02720) during access road cutting and filling activities. The access road will have a cross-slope directing surface water runoff from the road to the proposed drainage swale. The access road surface will be stabilized utilizing geotextile fabric and On-Site Surface Stone Aggregate per Specification Section 02936. The area between the property boundary and the outside edge of the access road shall be graded to match existing grades along the fence and restored with On-Site Surface Stone Aggregate. The drainage ditch and outside face of the containment cell berms will be restored using sod installed in accordance with the requirements of Specification Section 02936.

6.8.3 Storm Water Management Basin

The storm water management (SWM) basin will be situated on the east side of the containment cell as shown on the design drawings. The SWM basin will include the sediment fore-bay, intended to receive runoff and enhance sedimentation; and a storm water detention area, intended to hold storm water runoff during controlled discharge. The Contractor is required to collect and manage storm water runoff from active work zones and disturbed areas of the site in accordance with the requirements of Specification Section 02715, to prevent the entry of potentially contaminated sediment or water into the SWM basin. The SWM Basin shall be constructed at time of site preparation after performing required soil remediation in excavation areas NW and ND1, clearing and grubbing, and stripping topsoil within the proposed area of disturbance.

The fore-bay will have a top elevation of 839.5 and bottom of 837.5 and provide approximately 0.5 acre feet of combined water and sediment storage. The fore-bay will be excavated after acceptable confirmatory sampling results have been received for the required soil remediation. Spoils generated during fore-bay excavation meeting the geotechnical requirements for structural soil fill can be utilized for construction of the containment cell berm, without the need for stockpiling and characterization sampling. The fore-bay will become inundated with water (either infiltrating groundwater during periods of high groundwater or surface water runoff) shortly after construction and therefore will not be vegetated or lined with stone. Sediment storage capacity of the fore bay will be maintained during corrective measures construction through periodic sediment removal as required based on sediment accumulation. A final cleaning will be performed when on-site soil remediation is completed. Removed sediment will be placed in the containment cell with the Contractor collecting and managing free liquid pursuant to Specification Section 02715.

The storm water detention area will be constructed concurrently with the sediment fore-bay area. The bottom of the detention area will require cutting to achieve required bottom elevations. Topsoil will be stripped, stockpiled and sampled to determine final disposition. The remaining subsoil will be cut as required to achieve the elevations shown on the design drawings. The detention area will have an outlet structure situated as shown on the design drawings. The outlet structure a precast concrete inlet box, will have a 12-inch diameter orifice plate (invert = 837.25) that will function as the discharge device for the detention basin. The 15-inch diameter CPE culvert from the containment cell drainage ditch will be connected directly to the outlet structure. A 15-inch diameter CPE pipe (invert elevation out = 837.15) will convey water from the retention basin and drainage ditch culvert to the railroad spur drainage ditch. The bottom of the retention area of the SWM Basin will be stabilized with On-Site Surface Stone Aggregate, as specified in Section 02936.

6.8.4 Surface Impoundment

Following receipt of acceptable confirmatory sampling results within the footprint of the lagoon and adjacent on-site corrective measures excavation area OE1, the remaining depression will be backfilled and surrounding area restored. Backfilling within the former lagoon footprint will be performed using granular fill or structural soil fill below elevation 840 (as dictated by geotechnical conditions and discretion of the QA Representative) and using structural soil fill above. Care shall be taken to prevent disturbance of the lawn areas outside the exclusion zone fence. Finished grading shall promote drainage of surface water runoff towards the pavement proposed to remain in place (Sheet 9) and is expected require minimal amounts of cutting in the OE1 excavation area. Materials used as backfill will be placed in lifts and compacted in accordance with the project earthwork specifications (Section 02210).

6.8.5 General On-Site Surface Restoration

Following completion of remediation, the Site areas will be regraded to allow surface water to runoff from the site to the drainage ditches along the CSX right-of-way and South Arlington Avenue without the use of the pump houses. Existing pavement will remain in the areas of the site not proposed for soil remediation except to the extent required to facilitate post remediation storm water drainage. Rough grading will be performed by cutting and filling the ground surface remaining after completion of soil excavation activities. The Contractor will be permitted to "borrow" structural soil fill from completed excavation areas FL-2, FL-3, FL-4A and FL-5, and will backfill the resulting excavation with excess topsoil (stripped from within the area of the containment cell and storm water management basin demonstrated to have a total lead concentration <920 mg/kg and antimony, arsenic, cadmium and selenium equal to or less than the HWMU closure values). The volume of borrow will be dictated by the volume of excess topsoil. The finished surface on-site will be restored with On-Site Surface Stone Aggregate, the only exceptions being the areas between the interior and exterior security fences along South

Arlington Avenue which are proposed for turf restoration. On-site drainage ditches will be lined with Drainage Ditch Aggregate. The requirements for drainage ditch aggregate, on-site surface stone, and turf are provided in Specification Section 02936.

6.8.6 Off-Site Backfill and Restoration

Off-site areas will be restored to the pre-remediation condition unless otherwise approved by the property owner. Backfill will consist of imported structural soil and stone and imported topsoil and/or sod. The drainage ditch along South Arlington Avenue will be restored using sod. The drainage ditches along the CSX right-of-way will be restored using rip-rap stone in the bottom and railroad ballast on the embankment and surrounding ground surface. Information regarding the physical and analytical requirements for aggregate and soil used for restoration are provided in the Specifications.

6.9 SITE DEED RESTRICTION

Upon completion of site soil and sediment remediation and associated restoration, RMC will record a restriction on the deed for the RMC property. The deed restriction will restrict the use of the property to only commercial/industrial land use, and prevent installation of on-site potable groundwater wells.

7.0 PERMITTING REQUIREMENTS

This section describes federal, state, regional, and local permits and approvals required for implementation of Corrective Measures. This section also discusses site access and easement agreements or other arrangements with adjoining landowners necessary for implementation of Corrective Measures. A discussion of the application requirements and timeline for each item is provided below.

7.1 FEDERAL PERMITS

At this point in time, no federal permits are anticipated.

7.2 STATE PERMITS

7.2.1 Rule 5 – General National Pollutant Discharge Elimination System (NPDES) Permit for Storm Water Run-off Associated with Construction Activity

Indiana Administrative Code Rule 5 (327 IAC 15-5) is a performance-based regulation designed to reduce pollutants that are associated with construction and/or land disturbing activities. The requirements of Rule 5 apply to all persons who are involved in construction activity (which includes clearing, grading, excavation and other land disturbing activities) that results in the disturbance of one (1) acre or more of total land area.

RMC will submit application under Rule 5, which will include the following:

- Notice of Intent Letter
- Construction Plan

- Project Narrative and supporting documents
- Vicinity Map
- Existing Project Site Layout
- Final Project Site Layout
- Grading Plan
- Drainage Plan
- Storm Water Pollution Prevention Plan
- Post Construction Storm Water Pollution Prevention Plan

7.3 CITY OF INDIANAPOLIS PERMITS

7.3.1 Office of Code Enforcement

7.3.1.1 **Drainage**

The Office of Code Enforcement (Office) requires that land alterations be compliant with standards and practices that result in proper storm water drainage and sediment control. The Office has indicated through conversation with AGC that a Mass Earthwork Permit may apply for Corrective Measures. The Mass Earthwork Permit is a drainage permit for projects involving earth disturbance without the construction of buildings. As a general rule, all land alterations in industrial developments require:

- Storm water permit application
- Storm water plans
- Technical information report
- Sediment and erosion control plan
- BMP operation and maintenance manual

As per the Office, construction observation services, testing, and 'record' drawings shall be provided for all industrial developments that plan land disturbance of 5 acres or more.

Once construction begins, the Contractor will be responsible for informing and/or notifying the Office's observer assigned to the following:

- Daily work schedule including any changes in schedule
- Prior notification if work is to be performed on weekends and/or holidays
- Date mandrel tests are to be performed
- Date 'as-built' verification is to be performed

The Office, upon request of the Contractor and/or owner, will schedule the final inspection.

As per Office direction, RMC will submit application for a Drainage Permit which will include completion of the following forms:

- Certification Sufficiency of Plan (Drainage)
- Certificate Obligation to Observe (Storm Water)
- Infrastructure Plan Review Submittal

Upon review of RMC's submission, the Office will determine if the Marion County Soil and Water Conservation District will be involved in the review process. Upon approval, the Office will provide RMC with an Approval Letter, which will need to be included in RMC's Notice of Intent (NOI) submittal to the Indiana Department of Environmental Management (IDEM) for Rule 5 General Construction NPDES Permit application.

7.3.1.2 **Improvement Location Permit**

Temporary office trailers will be required to support Corrective Measures activities. A permit will not be required for these trailers as the Office designates "movable, temporary use structures or buildings utilized during construction projects" as specific exemptions that do not necessitate an Improvement Location Permit. However, the Office stipulates that all provisions and regulations of the City of Indianapolis Industrial Districts Zoning Ordinance shall continue to apply to exempted structures and improvements.

7.3.1.3 **Right-of-Way Permit**

RMC will submit application for excavation within the South Arlington Avenue public right-of-way which will include, at a minimum, the following:

- A properly executed permit application, in the form designated by the Marion County Department of Code Enforcement Department, including but not limited to, the following information:
  - The name and address of the contractor responsible for work;
  - The nature of, and the reason for, the work to be performed;
  - The location of the worksite and the dimensions of the excavation;
  - The anticipated length of time to complete the work;
  - The method of traffic control to be used by the applicant at the worksite;
  - An indemnification agreement; and,
  - Any other pertinent information requested by the Department.
- A general liability insurance policy.

- A performance and maintenance bond.

- Approval from the Department if the proposed work involves a sanitary sewer, storm sewer, affects drainage within the public right-of-way, or as required.

7.3.2 Department of Metropolitan Development

7.3.2.1 **Industrial Districts Zoning Ordinance**

The Site is designated as an I-3-S Medium Industrial Suburban District and I-4-S Heavy Industrial Suburban District and the Official Thoroughfare Plan for Marion County designates South Arlington Avenue as a Primary Arterial. The proposed containment cell will fall in both the I-3-S and I-4-S zoning districts. Although not representing a "structure" as defined under the zoning regulations, the cell has been situated to provide 30 feet of set back from the north and west property lines which represent the side and back yards of the property respectively. The setback from South Arlington Avenue, as measured from the centerline of the proposed berm will be approximately 190 feet at its closest point. The areas within the setbacks will be utilized as storm drainage and storm water management controls.

The containment cell does not appear to represent a "use" under the Industrial Zoning Ordinances, although both zoning districts include provisions for "industrial waste disposal facilities." The Performance Standards for both districts state that plans and specifications for proposed industrial waste disposal facilities shall be submitted to, and written approval obtained from, IDEM and the City of Indianapolis, Division of Compliance before an Improvement Location Permit will be issued. The final CMD will be submitted to the City of Indianapolis division of Compliance for written approval.

7.4 CITY OF BEECH GROVE PERMITS

Conversations with the City of Beech Grove and the City of Indianapolis indicate that, due to the nature of corrective measures, jurisdiction of the majority of work to be performed will be with the City of Indianapolis, Division of Compliance. No permits are expected to be required except for temporary facilities mobilized for completion of the work, although the City will be provided copies of the Final CM Design to confirm the representations made during the initial conversations.

8.0 PUBLIC RELATIONS

Refined Metals Corporation (RMC) developed a Community Relations Plan as an attachment to the RFI Work Plan. Components of the existing Community Relations Plan include a document repository (currently located at the Beech Grove Public Library), semi-annual news letters to a specified mailing list, maintaining open communications with local officials, and conducting public meetings when warranted based on the level of public interest.

9.0 SCHEDULE AND COST ESTIMATE

9.1 SCHEDULE

Based on the corrective measures activities anticipated by this Final Corrective Measures Design, RMC is anticipating a construction period on the order of 4 to 6 months, although ultimately schedule will be dictated by the approach of the selected contractor. A critical path style schedule has been developed and is provided as Attachment G.

9.2 COST ESTIMATE

A preliminary construction cost estimate is provided as Attachment F. The cost estimate has been developed using a unit price and estimated quantity format. As shown, the September 2010 estimate is $1,159,744.

10.0 POST CORRECTIVE MEASURES STORM WATER MANAGEMENT

Post corrective storm water management will consist of a gravity storm water system that will convey storm water runoff from the former impervious manufacturing areas of the site and the eastern portion of the proposed containment cell cap through a storm water management basins situated along the east side of the proposed containment cell. The storm water management basin will cover approximately 1.2 acres and have a storage capacity of approximately 80,000 cubic feet. The outlet structure will be a 15-inch diameter reinforced concrete pipe with an invert elevation of 837.25 that discharges into the railroad ditch along the CSX property. The proposed discharge towards the north coincides with the original storm water discharge for the manufacturing areas of the site prior to construction of the storm water collection and treatment system.

Swales will convey the storm water runoff from the restored areas of the site to the storm water management basin as shown on Sheet 6. The total drainage area to the basin is 9.5 acres with an average CN value of 91. Pondpack® was utilized to perform the storm water management calculations following the SCS Unit Hydrograph Method. As presented on the calculations (Attachment C), the basin will detain the storm event and attenuate the flows as follows:

DESIGN STORM	INFLOW (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	STORAGE (Ac-ft)
2	24.9	3.28	838.50	0.594
5	37.31	4.08	838.92	0.946
10	43.51	4.43	839.13	1.132
25	52.78	7.08	839.38	1.367
50	58.93	9.68	839.54	1.512
100	68.12	12.32	839.78	1.742

In addition to the flows through the storm water management basin, approximately fifty percent of the containment cell cap will drain into a trapezoidal swale along the west and north sides of the cell, before draining through a 15" ø culvert. The swale will function as a storm water management basin for the 1.3 acre area as follows.

DESIGN STORM	INFLOW (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	STORAGE (Ac-ft)
2	2.61	1.61	838.37	0.031
5	4.27	2.49	838.66	0.052
10	5.13	2.85	838.79	0.063
25	6.44	3.27	838.99	0.083
50	7.31	3.47	839.10	0.097
100	8.63	3.75	839.28	0.120

11.0 POST CLOSURE INSPECTION AND MAINTENANCE

The post closure inspection and maintenance plan is provided as Attachment E.

ATTACHMENT B

Construction Specifications Replacement Pages

SECTION 01010

SUMMARY OF WORK

PART 1: GENERAL

1.1 DESCRIPTION OF WORK

The Work to be performed under these Specifications represents the proposed Corrective Measures to be completed by Refined Metals Corporation (RMC) to address elevated concentrations of lead and associated inorganic compounds in soil, sediment and groundwater identified on and around the RMC facility in Beech Grove, Marion County, Indiana. Major components of the Work include the following:

A. Installation and maintenance of erosion and sediment control measures, storm water management controls, temporary access controls, and decontamination facilities associated with the proposed work.

B. Clearing, grubbing and disposal of brush and trees from within areas of proposed remediation and containment cell construction.

C. Construction of a containment cell for consolidation of excavated soil, “sediment”, and designated debris.

D. Excavation of on-site soil exceeding 970 mg/kg total lead, 37 mg/kg antimony, 20 mg/kg arsenic, 77 mg/kg cadmium and 53 mg/kg selenium within HWMU areas, as shown on the Hazardous Waste Management Unit Closure Plan (Sheet 6).

E. Closure of the on-site surface impoundment (lagoon) and demolition of its concrete liner component following removal of liquid, bulk sediment, vegetation, liner material and miscellaneous debris.

F. Excavation of on-site soil from areas outside the HWMUs exceeding 4,954 mg/kg total lead in “grassy” exposure areas and 8,470 mg/kg total lead in paved exposure areas, as shown on Soil and Sediment Excavation Plan East (Sheet 7).

G. Excavation of soil and “sediment” exceeding 400 mg/kg total lead in off-site areas, as shown on Soil and Sediment Excavation Plans East and West (Sheets 7 and 8).

H. Handling, loading, transporting and placement of excavated materials in the containment cell.

I. Identification of borrow sources for; and procurement of topsoil, structural soil fill, general site fill, cap soil fill, and granular fill meeting the requirements of these Specifications.

J. Restoration of those areas of the site disturbed as a result, directly or indirectly, of the soil excavation activities and associated work.

K. Mobilization and operation of a temporary water treatment system for accumulated stormwater and groundwater from disturbed site areas and decontamination water.

L. Operation of existing storm water management system (pumps and piping) from the time of mobilization through site stabilization and initiation of gravity storm water drainage through proposed discharge features.

M. Establish stormwater drainage and management system capable of capturing, controlling and discharging stormwater runoff without the use of pumps.

1.2 RELATED SECTIONS

A. Corrective Measures Design (including all Attachments)

B. All Sections of these Specifications

1.3 CONTRACTOR RESPONSIBILITIES

A. Furnish all materials, tools, equipment, supervision, administration and transportation, and perform all labor and services necessary to furnish, deliver, construct, install, and/or complete all Work described in the Contract.

B. As necessary for proper execution and completion of work and as applicable, secure and pay for required permits, licenses, health and safety training, and medical monitoring for its own employees working at the site.

C. Provide at least 2 weeks advanced notification of commencement of mobilization.

D. Locate and protect existing utilities prior to working in or adjacent to areas containing existing utilities pursuant to the requirements of the Indiana One-Call system and through the use of a private utility locator.

E. Until final acceptance of the Work by RMC, the Contractor shall have the charge and care thereof and shall take every reasonable precaution against injury or damage to the completed work. The Contractor shall repair, restore, and make good, to the satisfaction of RMC all damages to any portion of the work before final acceptance and shall bear the expense thereof.

F. Contractor shall provide experienced, competent and trained personnel to perform the Work. Contractor shall provide, at a minimum, a project superintendent familiar with all details of the project, adept at the designated position and capable of communicating with Contractor personnel, and representatives of RMC, USEPA, and IDEM.

G. Contractor shall be responsible for providing barriers, safety guards, signage and temporary fencing as required by the owners of the properties where work is being performed, and as required by appropriate safety regulations.

1.4 CONTRACTOR USE OF WORKSITE

A. General

1. The Contractor shall confine operations at the site to areas indicated on the design drawings and shall not unreasonably encumber the site with any materials or equipment.

2. The Contractor shall limit their work on properties not owned by RMC to between the hours of 7:00 a.m. and 6:00 p.m., Monday through Friday, except legal holidays. Work on RMC property shall be limited to 6:00 a.m. to 7:00 p.m., Monday through Friday and Saturday 7:00 a.m. to 5:00 p.m., unless otherwise restricted by local ordinance. Additional working hours, or work on Sundays will only be permitted with prior approval by RMC.

3. Keep existing driveways and entrances serving the site clear and available at all times.

4. Consider the safety of the Work, and that of people and property on and adjacent to worksite, when determining amount, location, movement,

installation, and use of materials and equipment on worksite. Work zone safety fencing shall be used to demark active work zones outside the site security. Within the site security fence the Contractor shall provide protection around work zones in accordance with applicable regulatory statutes and as necessary to prevent uncontrolled access.

5. Site security shall be the Contractor's responsibility. RMC will maintain part-time dusk to dawn security service that consists of an unarmed guard visiting the site at irregular intervals during the night. RMC is not responsible for security of Contractor's equipment and materials.

6. Protect the general public from construction-related activities, conduct work in a manner, which will ensure that pedestrian and vehicular traffic will either not be obstructed or obstructed to the least possible degree.

7. Work on non-RMC property will be subject to limits and restrictions imposed by property owner.

1.5 EXISTING CONDITIONS

A. The existing conditions represented on the design drawings are based on the best available information obtained from one or any combination of the following sources: field survey, aerial photographs, reference drawings, or visual evaluations. The Contractor shall retain an Indiana Licensed Professional Surveyor to document starting conditions and establish vertical and horizontal controls for the project.

B. If conditions are significantly different to those presented on the design drawings such that they could affect the schedule, cost or execution of the work, the Contractor shall submit a detailed description of the conditions observed within two work days of their identification.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

Not Used.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01050

FIELD ENGINEERING

PART 1: GENERAL

1.1 DESCRIPTION

A. Work included: This Section of the Specifications covers field engineering services required for proper completion of the Work including, but not limited to:

1. Establishing and maintaining lines and levels, including field locating the property north and west of the proposed Containment Cell.

2. Surveying pre-removal conditions (topography and physical features) within the limits of contaminated soils and sediment designated for removal, and establishing reproducible grids or cross-sections for controlling removal depths.

3. Documenting final removal limits using the grids and cross-sections described above.

4. Providing As-Built Drawings of restored site conditions as part of the final project closeout. As-Built Drawings shall also document the finished surface of the materials placed in the Containment Cell and top of the finished cap.

5. Structural design of shores, forms, and similar items provided by the Contractor (if any) as part of the means and methods of construction.

6. The Contractor will retain the services of an Indiana Licensed Professional Surveyor to perform pre-removal and as-built surveys. The Contractor may utilize his own equipment and personnel to provide grade control during excavation activities and document final removal limits, provided the techniques and equipment are acceptable to the QA Representative and tied into the vertical and horizontal controls established by the surveyor.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals

B. Section 02110 - Site Clearing and Grubbing

C. Section 02115 - Erosion and Sediment Control Measures

D. Section 02209 - Excavation/Handling/Placement

E. Section 02210 - Earthwork

F. Section 02831 – Fencing

1.3 DEFINITIONS

A. As-Built Drawings – Drawings at a similar scale and level of detail as the design drawings showing an accurate record of all deviations from the approved design drawings and Specifications which may occur in the Work as actually constructed. The Contractor will be provided with electronic copies of the design drawings for use in development of the As-Built Drawings. As-Built Drawings shall be signed and sealed by the Contractor's surveyor.

1.4 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. A land surveyor licensed to practice in the State of Indiana shall be directly responsible for survey work performed by the Contractor.

C. RMC will retain the services of a full-time Quality Assurance (QA) Representative to observe and document progression of the work and collect required post-excavation samples and perform other activities specifically designated in the Construction Quality Assurance Plan (CQAP) and Specifications.

D. The Contractor will be responsible for providing appropriately qualified personnel to perform Quality Control (QC) testing throughout the project, including performing air monitoring, compaction testing, liner installation and material testing.

1.5 SUBMITTALS

A. Comply with the pertinent provisions of Section 01300.

B. The Contractor shall provide, at a minimum, As-Built Drawings, signed and sealed by the Contractor's Surveyor, for the following components:

1. The initial excavation/removal work areas documenting original conditions.

2. Areas of clearing and grubbing and demolition quantities.

3. The final elevations of the site and off-site work zones and limits of each type of restoration (i.e., seeded vegetation, sod, and crushed stone/concrete).

4. All the reasonable items requested by RMC to verify that the Work meets the requirements of the Contract.

The Contractor shall submit As-Built documentation for review by RMC, with the request for final payment or at the completion of the applicable phases of the work.

C. The Contractor shall prepare a Daily Report detailing any and all work and health and safety activities that were performed. **<u>The Daily Report shall be prepared by noon the following work day and a copy submitted to the QA Representative</u>**. Results of Quality Control sampling and testing shall be provided as attachments to the Daily Report.

D. Contractor shall prepare and submit a Construction Schedule presenting the planned sequence for execution of the work. The Construction Schedule shall identify the sequence of excavation activities on a removal area by removal area basis, planned start and end dates for each major tasks, and other relevant information required for control of the work. The schedule shall be updated at least every two weeks to show actual versus planned progress and reflect changes in the schedule.

PART 2: MATERIALS

Not Used.

PART 3: EXECUTION

Not Used.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01200

PROJECT PROGRESS MEETINGS

PART 1: GENERAL

1.1 DESCRIPTION OF WORK

A. The Contractor will conduct project meetings throughout the construction period to enable orderly review during progress of Work and to provide for systematic discussion of problems. Project meetings will also include discussions regarding coordination and scheduling.

B. When requested by a property owner, the Contractor will be required to participate in a Pre-Construction Meeting specific to that property. At a minimum, this will include a meeting for work on Citizens Gas property. The agenda for such meetings will be established by RMC and the property owner. RMC will be responsible for issuing minutes for such meetings.

1.2 RELATED SECTIONS

A. All documents related to the Corrective Measures Design.

1.3 QUALITY ASSURANCE

A. The Contractor's Superintendent shall attend and participate in each project meeting and shall represent the Contractor consistent with the Contract and commit the Contractor to solutions and actions agreed upon during the project meetings.

B. The Contractor's relations with its subcontractors and discussions relative thereto, are the Contractor's responsibility. The Contractor will be required to include key subcontractors (such as the liner installer) in project meetings when related work is being planned or discussed.

1.4 SUBMITTALS

A. Agenda items:

1. To the maximum extent practicable, the QA Respresentative will advise the Contractor at least twenty-four (24) hours in advance of project meetings regarding items to be discussed during the meeting.

2. Technical questions requiring the QA Representative's, Engineer's or RMC's response shall be submitted in writing, at least one (1) day prior to the project meeting.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

3.1 MEETING SCHEDULE

A. Project meetings will be held weekly at a regularly scheduled time and day to be mutually agreed upon between the Contractor, RMC and regulatory agencies. When work is being performed, planned, or discussed on non-RMC property, the property owners will also be invited to participate in the project meetings. From time to time or during periods of reduced activity, the frequency of the meeting may be switched to bi-weekly. The day and time of the meetings may be moved with concurrence of the Contractor, RMC, USEPA and IDEM.

3.2 MEETING LOCATION

A. The Contractor shall provide adequate space at the site for progress meetings and provide conference call capabilities for participation from remote locations.

3.3 PROJECT MEETINGS

A. Minimum agenda for each meeting:

1. Attendance

2. Review of safety issues/concerns and latest sampling results.

3. Review progress of Work since last meeting, including status of submittals for approval.

4. Identify problems, which impede planned progress.

5. Develop corrective measures and procedures to regain planned schedule, if applicable.

6. Contractor shall provide and discuss "two-week look ahead" activity schedule if the work is not progressing per the early start/finish activity dates as noted in the latest update of the approved schedule.

7. Complete other current business.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1: GENERAL

1.1 DESCRIPTION

A. This Section of the Specifications covers all submittals including material specifications and manufacturer's data; proposed subcontractors qualifications and insurance information, panel placement plan for geomembrane installation, sequence of construction information, schedule, and borrow source testing information. Contractor shall make submittals utilizing a standardized transmittal form acceptable to the QA Representative.

B. Upon award of the Contract, but no later than fourteen (14) calendar days before mobilization the Contractor shall prepare a submittal register for review and approval by the QA Representative.

1.2 RELATED SECTIONS

A. The appropriate Sections of Division 1 and Division 2 of these Specifications.

1.3 SUBMITTAL REGISTER

A. The submittal register shall be submitted no later than fourteen (14) calendar days before mobilization. The submittal register shall include all submittal items listed in the Specifications and shall also provide the following information, at a minimum:

1. Project name;

2. Contractor's project or reference number;

3. Submittal title and description of item and Specification section;

4. Submittal reference number sequentially numbered; and

5. Columns for submittal date, response date and approval status.

B. The submittal register shall include blank rows for future addition of submittals that were not anticipated. Upon inclusion of additional line items in the submittal register, the Contractor shall resubmit an updated submittal register for use by RMC and the Engineer.

1.4 SUBMITTAL SCHEDULE

A. The Contractor is required to make submittals sufficiently in advance of delivery of associated materials or commencement of associated work to allow review and response by the QA Representative. While the QA Representative will strive to turnaround submittals as quickly as possible, the Contractor should anticipate that submittals will require 5 days for review and response. Submittals that are considered incomplete or item unacceptable will be returned and will require resubmission.

1.5 SUBMITTALS

A. The minimal information required for each submittal is found in its respective Section of these Specifications. The following is a partial list of submittals related to the project:

1. Construction Schedule and Narrative Sequence of Construction
2. Contractor's Health and Safety Plan
3. Subcontractor's Qualifications and Insurance Information
4. Temporary Water Treatment System Information
5. Geotechnical and Analytical Data for Proposed Borrow Sources
6. Manufacturers Specifications and Cut-Sheets for Materials
7. Geomembrane Installer's Panel Placement Plan
8. As-Built Drawings

B. A submittal cover sheet or transmittal sheet shall accompany each submittal and shall include all information specified in these Specifications. The transmittal sheets shall be sequentially numbered and shall be of the same format for all submittals.

C. Submittals will be reviewed by the QA Representative. Where appropriate, the QA Representative will solicit input from RMC or the Engineer regarding the adequacy/acceptability of the proposed item.

D. The Contractor shall apply a stamp or signature certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the Contract Documents.

E. The results of review of submittals will be used as follows:

1. NO EXCEPTIONS TAKEN;

2. PROCEED AS NOTED; REVISE AND RESUBMIT FOR RECORD;

3. DO NOT PROCEED; REVISE AND RESUBMIT;

4. REJECTED; or,

5. NOT APPLICABLE.

F. Submittals not in compliance with the Specifications will be returned to the Contractor for revision. Any loss of time and additional costs associated with resubmittal(s) are the Contractor's responsibility.

G. Submittals that are "Proceed as Noted" are for the purpose of expediting procurement of the intended work. The Contractor shall incorporate all corrections and resubmit revised submittal to QA Representative within seven (7) calendar days of the "Proceed as Noted" action. Payment for completed work that is related to the "Proceed as Noted" submittal will not be made until the corrected and final resubmittal is accepted in writing by the QA Representative.

1.6 SUBSTITUTIONS

A. "Or Equals" Substitutions

1. Equals Considered - Whenever a material or article required is specified or shown on the plans by using the name of the proprietary product or of a particular manufacturer or vendor, any material or article which will perform adequately the duties imposed by the general design, will be considered equal and satisfactory provided the material or article so proposed is of equal properties and function in the opinion of QA Representative.

2. The Contractor shall document each request with complete data substantiating compliance of the proposed Substitution with the Contract Documents. "Or Equal" requests will be considered only when substantiated by the Contractor's submittal of data documenting the "Or Equal" nature of material or article. A request constitutes a representation that the Contractor:

   a. Has investigated the proposed product and determined that it meets or exceeds the quality level of the specified product.

   b. Shall provide the same warranty for the substitution as for the specified product.

   c. Shall coordinate installation and make changes to other work, which may be required for the Work to be complete with no additional cost to RMC.

   d. Shall waive claims for additional costs or time extension, which may subsequently become apparent.

   e. Shall reimburse RMC for review or redesign services associated with review and approval.

   d. Shall waive claims for additional costs or time extension, which may subsequently become apparent.

3. The Contractor shall provide substitutions in a timely manner and in accordance with the CMD and the Contract with RMC, so as to not have a negative impact on the Construction Schedule.

1.7 PRODUCT DATA

A. Collect product data into a single submittal for each element of fabrication or system. Product data includes printed information such as manufacturer's installation instructions, catalog costs, standard color charts, roughing-in diagrams and templates, standard wiring diagrams and performance curves.

B. Mark each copy to show applicable choices and options. Where product data includes information on several products, some of which are not required, mark copies to indicate the applicable information.

C. Do not submit product data until compliance with requirements of the Contract Documents has been confirmed.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

3.1 IDENTIFICATION OF SUBMITTALS

A. The Contractor shall consecutively number all submittals.

1. When resubmittal(s) is made for any reason, the Contractor shall transmit under a new letter of transmittal with a new transmittal number.

2. On resubmittals, the Contractor shall cite the prior transmittal number(s).

B. The Contractor shall maintain an accurate submittal log for the duration of the Work, showing current status of all submittals at all times. The Contractor shall make the submittal log available for review upon request.

3.2 GROUPING OF SUBMITTALS

A. Unless otherwise specified, the Contractor shall make submittals in groups containing all associated items to assure that information is available for checking of each item when it is received.

B. Partial and poorly prepared submittals will be rejected as not complying with the requirements of the Contract. The Contractor will be liable for related delays.

3.3 TIMING OF SUBMITTALS

A. In scheduling, the Contractor shall allow five (5) calendar days for review and processing by the QA Representative following its receipt of the submittal.

This review time will be increased for the submittal(s) that are so extensive that the five (5) calendar day turn around period is unreasonable, as determined by the QA Representative.

C. It is understood that work affected by the submittal may progress only after the QA Representative has returned the approved, signed and stamped transmittal cover sheet to the Contractor. The Contractor will be responsible for the repair, modification or removal of completed work, which had not been approved.

3.4 QA REPRESENTATIVE'S REVIEW

A. Review and Processing shall not relieve the Contractor from responsibility for errors, which may exist in the submitted data.

B. Revisions:

1. The Contractor shall make required revisions as noted on initial submittal.

2. If the Contractor considers any required revision to be a change, it shall so notify RMC in writing within 3 calendar days.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01351

HEALTH AND SAFETY PLAN REQUIREMENTS

PART 1: GENERAL

1.1 DESCRIPTION

A. The Work of the Contract covered by this section shall include the development and implementation of a Health and Safety Plan (HASP) for all proposed Corrective Measures activities contemplated as part of the proposed Work. The Contractor shall provide all expertise, supervision, labor, materials, and equipment necessary to develop, prepare, and implement the Health and Safety Plan as detailed in this Section and as accepted by USEPA, IDEM and RMC.

B. The Contractor shall develop and implement all necessary precautions for the safety of, and provide the necessary protection to prevent damage, injury or loss to:

- All employees and subcontractors participating in performance of the Work.
- All components of the Work, any materials to be used or incorporated in the Work, and any equipment to be employed in the execution of the Work, whether on- or off-site.
- Other property on or adjacent to the project site including trees, shrubs, lawns, fences, sidewalks, pavements, roadways, structures and utilities not designated for removal, relocation, or replacement in the course of construction.
- Adjacent property of owners/landowners and residents.

1.2 RELATED SECTIONS

A. All of the CM Design (including all attachments).

B. United States Federal Government - Code of Federal Regulations (CFR)

1. 29 CFR 1910 – Occupational Safety and Health Standards

2. 29 CFR 1910.120 - Hazardous Waste Operations and Emergency Response

3. 29 CFR 1910.134 - Respiratory Protection

4. 29 CFR 1910.1200 - Hazard Communication

5. 29 CFR 1926 - Construction Standards

6. 29 CFR 1910.1025 – Lead in Construction

1.3 QUALITY ASSURANCE

A. The Contractor's draft Health and Safety Plan (HASP) will be reviewed for content by the USEPA, IDEM and RMC. Each will return comments within one week from receipt of the draft HASP.

B. The Contractor shall carefully review and consider all elements of the Work of the Contract during preparation of the HASP and verify that all elements of the Contract Documents are thoroughly addressed. Incomplete or missing elements in the HASP will create delays in approval which will delay the commencement of Work.

1.4 GENERAL PLAN REQUIREMENTS

A. The Contractor shall develop a written site-specific HASP which complies with applicable regulations under the Code of Federal Regulations prior to commencing any on-site work and continue to implement, maintain, and enforce the HASP until final demobilization from the site.

B. The health and safety guidelines contained herein are intended to provide for a safe and minimal risk working environment for on-site personnel and to minimize the impact of activities involving contact with excavated soils on the general public and the surrounding environment.

C. The Contractor shall be responsible for the safety of persons and property on the site and for the protection of persons off the site and the environment to the extent that it may be affected by the conduct of the Work. The Contractor shall comply with and enforce compliance by employees of the Contractor and subcontractors with safety requirements of the CMD, laws and regulations, and HASP.

D. Hazard Communication Requirements:

1. The Contractor shall comply with the requirements of OSHA's Hazard Communication rule, 29 CFR 1910.1200, obtaining information on any hazardous chemical or harmful physical agent to which personnel of the Contractor and subcontractors, and visitors have potential exposure during the Work.

2. The Contractor shall include Material Safety Data Sheet (MSDS) documentation on any hazardous chemicals that the Contractor and/or its subcontractor's plan to utilize for the Work. In addition, the Contractor shall be responsible for meeting container warning label requirements in accordance with OSHA.

E. Work Stoppage: The Contractor shall give precedence to the safety and health of the public and on-site personnel and the protection of the environment for all Work. The Contractor's designated health and safety officer shall be responsible for decisions regarding when the Work will be stopped and re-started for health or safety considerations. The Contractor shall be responsible for all costs and delays at no extra cost to RMC.

F. Unforeseen Hazards: Should any unforeseen or site-specific safety-related factor, hazard, or condition become evident during performance of the Work at the Site, the Contractor shall bring such to the attention of RMC verbally and in writing as quickly as possible, for resolution. In the interim, the Contractor shall take prudent action to establish and maintain safe working conditions and to safeguard employees of Contractor and its subcontractors, the public, the property owner, RMC and its representatives, and regulators.

1.5 BASIS OF PROGRAM

A. OSHA standards and regulations contained in 29 CFR 1910 and 1926 provide the basis for the health and safety program. The program also reflects the position of USEPA and NIOSH regarding procedures recommended or required to ensure safe operations at sites containing hazardous or toxic materials.

1.6 SITE CHARACTERIZATION

A. Based on past sampling activities, work at the site will involve contact with materials containing lead, arsenic and other metals. Results of soil and sediment sampling are provided in the design drawings.

1.7 SUBMITTALS

A. The Contractor shall submit the draft Health and Safety Plan (HASP) in electronic format to RMC for review and comment at least two weeks prior to the start of work. The Contractor's HASP shall include; but is not limited to, required drawings, figures, tables, forms, resumes and appendices.

B. The Contractor shall not proceed with the Work until RMC, the USEPA and IDEM have accepted the Contractor's HASP.

C. The Contractor's HASP shall be a stand alone document that correlates health and safety procedures to each work element in a clear and concise manner.

D. Health and Safety Plan shall include the following:

1. Site control measures in accordance with 29 CFR 1910.120 (d) and 29 CFR 1926.65 (d).

2. A safety and health risk or hazard analysis for each site task and operation, including measures or controls for each task/operation.

3. Personnel training assignments in accordance with 29 CFR 1910.120 (e) and 29 CFR 1926.65 (e), 29 CFR 1910.1001 (j), and 29 CFR 1910.1025 (l).

4. Personal protective equipment to be used by personnel for each site task and operation being conducted in accordance with 29 CFR 1910.1209 (g)(5) and 29 CFR 1926.65 (G)(5).

5. Medical surveillance requirements in accordance with 29 CFR 1910.120 (f) and 29 CFR 1926.65 (f).

6. Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment to be used.

7. Decontamination procedures in accordance with 29 CFR 1910.120 (k) and 29 CFR 1926.65 (k).

8. A written respiratory protection program for project activities.

9. Procedure for dealing with heat and/or cold stress.

E Air Monitoring Reporting: **Submit daily**, on a separate Contractor designated form, air monitoring results.

PART 2: PRODUCTS AND PERSONNEL

2.1 DESIGNATED HEALTH AND SAFETY OFFICER

A. Employ and assign to the Work a competent and authorized representative herein referred to as the Health and Safety Officer. Health and Safety Officer Qualifications:

1. Site-related working experience specific to the activities associated with soil remediation projects.

2. Have a basic working knowledge of state and federal occupational safety and health regulations.

3. Have formal education and/or training in occupational safety and health.

B. Health and Safety Officer Responsibilities:

1. Obligated to stop or start the work when it is necessary or advisable for reasons of health or safety.

2. Completing daily health and safety training sessions (i.e. "tailgate meetings").

3. Implementing and daily enforcement and monitoring of the site-specific HASP.

4. Be on the site during the execution of Work at the site.

2.2 PERSONNEL HEALTH, SAFETY, AND HYGIENE

A. Medical Surveillance: Conduct medical surveillance of personnel as required by 29 CFR 1910.120, 29 CFR 1926.65, and 29 CFR 1910.134.

B. Training: Furnish personnel assigned to or entering the site who have successfully completed training required by the applicable OSHA Standards in 29 CFR 1910 and 29 CFR 1926 and specifically with 29 CFR 1910.120 and 1926.65.

C. Levels of Protection: Establish actual levels of protection for each task based on planned activity and location of activity.

D. Personal Protective Equipment (PPE):

1. Furnish on-site Contractor personnel with appropriate PPE. Clean and maintain safety equipment and protective clothing. As a minimum, each worker on-site shall wear a hard hat, safety glasses with side shields, safety boots with steel toes and shank, and full-length pants.

2. Develop protective equipment usage procedures and enforce strict compliance with such procedures by on-site personnel.

E. Respiratory Protection

1. Furnish on-site personnel with training in the usage and limitations of, and qualitative fit testing for, air purifying and supplied-air respirators in accordance with 29 CFR 1910.134.

2. Develop, implement, and maintain a written respiratory program in accordance with 29 CFR 1910.134.

3. Monitor, evaluate, and provide respiratory protection for on-site personnel, as appropriate.

4. Immediately notify RMC if level of respiratory protection required increases from Level D to Level C.

F. Heat Stress/Cold Stress: Implement a heat stress and/or cold stress monitoring program as applicable and include in the site-specific Health and Safety Plan.

G. Personnel Hygiene and Personnel Decontamination Procedures.

1. Provide, as a minimum, the following:

   a. Suitable containers for storage and disposal of used disposable PPE.

   b. Potable water and a suitable sanitation facility.

H. Emergency and First-Aid Equipment

1. Locate and maintain emergency and first-aid equipment in appropriate location on the site, including:

   a. First-Aid kit to accommodate the number of on-site personnel.

   b. ABC type dry chemical fire extinguishers.

2. As a minimum, provide one (1) certified first-aid technician on the site at all times when on-site work activities are in progress. This technician may perform other duties but shall be immediately available to render first aid when needed.

I. Site Communications:

1. Post emergency numbers near the site telephones.

2. Furnish selected personnel with 2-way radios.

J. Safety Meetings: Conduct mandatory daily safety meetings for on-site personnel, and additionally as required by special or work-related conditions; include refresher training for existing equipment and protocols, review ongoing safety issues and protocols, and examine new site conditions as they are encountered. Hold additional safety meetings on an as-needed basis.

K. The Contractor shall be responsible for keeping safety equipment and facilities clean, properly equipped, and maintained. The Health and Safety Officer may perform other duties for Contractor but the first priority shall be maintenance of protective equipment and the personnel decontamination area.

2.3 AIR MONITORING

A. The Contractor shall develop an air monitoring program meeting the requirements of 29 CFR 1910.120 (h) and 29 CFR 1926.65 (h).

B. The Contractor shall monitor the progress of work activities, monitor air quality in and around the exclusion zone. The Contractor shall conduct all required air monitoring.

C. The Contractor shall provide the required instruments for air monitoring including, but not limited to, as a minimum:

1. Dust monitor (mini Ram or equivalent).
2. High-Volume Air Monitors

D. The Contractor shall operate air monitoring equipment with personnel trained in the use of the specific equipment provided under direct control of the Contractor's health and safety officer.

E. The Contractor shall conduct all required air monitoring during the Work of the Contract.

2.4 SITE CONTROL

A. The Contractor shall comply with 29 CFR 1910.120 (d) and 20 CFR 1926.65 (d).

B. The Contractor shall provide in the HASP a figure or map which presents the delineation of the work zones for Project activities considered in the Work of the Contract.

C. The Contractor shall provide in the HASP a discussion on Site security issues.

D. The Contractor shall provide in the HASP a detailed discussion on decontamination procedures for both equipment and personnel, including collection and disposal of wash waters and spent PPE.

PART 3: EXECUTION

3.1 HEALTH AND SAFETY PLAN

A. The Contractor shall prepare a written Health and Safety Plan which is applicable to all components of the Work. The HASP shall be based upon the requirements and guidelines described herein and all provisions of applicable law. The Contractor's HASP will apply to all personnel on-site including the Contractor and its subcontractors, RMC and its representatives, the property owners, the USEPA, the IDEM and other regulatory agencies. The Contractor shall include additional information as appropriate and may utilize any format provided it is neat, clean and complete.

B. The Contractor shall ensure that the HASP meets, at a minimum, the requirements of OSHA Standards and Regulations contained in Title 29, Code of Federal Regulations, Parts 1910 and 1926 (29 CFR 1910 and 1926).

C. In addition, the Contractor's HASP must include at a minimum, the following information:

- Responsibilities of the Contractor and its Health and Safety Officer and the name of the Health and Safety Officer and assistant health and safety personnel to be utilized on site.

- A description of the Work to be performed at the Site and how health and safety activities are related to the work.

- A hazard evaluation, including discussions of potential hazards involved with the Work.

- A discussion of proposed environmental and personnel monitoring including specific types of equipment to be used and action levels to be instituted.

- Personnel protection requirements for specific work areas, specific activities or specific tasks. The Contractor shall supply all personal protective equipment.

- Personnel and equipment decontamination procedures.

- Training requirements for personnel utilizing personal protective equipment. The Contractor shall provide 40 hours of classroom training supplemented with site-specific training as required by OSHA in 29 CFR 1910.120 for all personnel who will be working on-site prior to their initiating on-site work. Additionally, the Contractor's supervisory personnel shall receive an additional 8 hours of supervisory training.

- Daily and weekly safety logs and a closeout safety report to be prepared by the Contractor.

3.2 IMPLEMENTATION OF PLAN

A. Once the Health and Safety Plan (HASP) has been accepted by RMC, the USEPA and the IDEM, then the requirements of the HASP shall be enforced and the Contractor shall commence the remediation activities.

B. The Contractor shall provide an on-site Health and Safety Officer during all Work activities, appropriately trained and certified for supervisory responsibility in health and safety protection. An alternate Health and Safety Officer, with appropriate training, must be designated to serve when the Health and Safety Officer is not on-site.

C. It shall be the responsibility of the Contractor's Health and Safety Officer to ensure that all health and safety requirements are implemented per the approved HASP.

D The Contractor's Health and Safety Officer shall be responsible for personnel decontamination and emergency response measures.

E. The Contractor's Health and Safety Officer shall have the authority to act on all health and safety issues and matters, and to establish new controls, procedures or facilities as needed.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01355

WASTE MANAGEMENT AND DISPOSAL PLAN REQUIREMENTS

PART 1: GENERAL

1.1 DESCRIPTION

The proposed Work is not expected to generate a significant volume of waste materials requiring offsite disposal or recycling. The only anticipated waste materials requiring off-site management will be minor amounts of scrap metal destined for recycling, general refuse generated by the temporary office facilities and materials generated during the clearing and grubbing process. Depending on the amount of impacted soil excavated and the ultimate capacity of the containment cell, off-site disposal of some soil/sediment/debris may be required.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals

B. Section 01351 - Health and Safety Plan Requirements

C. Section 02110 – Site Clearing and Grubbing

D. Section 02150 – Demolition of Remnant Structures

E. Section 02209 - Excavation/Handling/Placement

1.3 SUBMITTALS

The Contractor shall submit for RMC approval the names and permit information for all proposed disposal or recycling facilities. Submittal shall include copies of current operating permits and proof of insurance for the facility and the name and contact information of regulatory inspectors.

PART 2: PRODUCTS

2.1 WASTE STORAGE AND SHIPPING CONTAINERS

A. The Contractor's containers utilized to store and transport the various waste materials shall be appropriately sized and compatible with the material being managed and approved for the intended use by the Department of Transportation.

PART 3: EXECUTION

3.1 GENERAL

A. Soil, sediment and miscellaneous debris generated during the remedial activities will be placed in the Containment Cell in accordance with the procedures contained in Specification Section 02209.

B. Only materials approved by the QA Representative will be released for off-site management.

C. The proposed corrective measures will require the removal of more than 2,000 cy of concrete pavement, floor slabs and wall (excluding the MSB floor). It is the intent of RMC as part of its "Green Remediation" efforts to segregate, crush and reuse the concrete. Specific information to the procedures related to the segregation, crushing and recycling are provided in Section 02150. If concrete can not be recycled because it fails analytical requirements established in the Specifications for re-use it shall be disposed in the Containment Cell.

D. The Contractor's submittals for proposed off-site recycling or disposal facilities shall include:

1. Characterization sampling required by each facility for each type of waste and the name and qualifications of the laboratory to provide the required analysis.

2. Waste management requirements for each waste stream including labeling, manifests and bills of lading, and record keeping.

3. Name, address, telephone number, contact name, copy of operating permits and proof of insurance for each proposed disposal facility.

4. Names, address, telephone numbers, contact name, copy of operating permits and proof of insurance for each proposed transporter.

5. Description of transportation operations for each waste material.

3.2 PREVIOUSLY UTILIZED DISPOSAL AND RECYCLING FACILITIES

During the decontamination and demolition activities, the following facilities were utilized:

1. Metals Recycling – OmniSource
2. Non-Hazardous Solid Waste – Southside Landfill Inc.
3. Hazardous Solid Waste – Heritage Environmental Services

PART 4: MEASUREMENT AND PAYMENT

Measurement and payment shall be as indicated in Specification 02110.

END OF SECTION

SECTION 01400

QUALITY ASSURANCE/QUALITY CONTROL

PART 1: GENERAL

1.1 DESCRIPTION

A. Work Included:

The Contractor shall establish and maintain a project specific Quality Control (QC) and management program (collectively QC program) for each component to be furnished and installed under the Contract Documents. Contractor shall have the "primary" responsibility for the quality of all its work and ensure that all materials meet the requirements established in these Specifications.

B. RMC will provide a full-time Quality Assurance Representative (QA Representative) to observe and document work activities and the Contractor's QC program. The Contractor shall be responsible for the implementation QC requirements of the Corrective Measures Design. The Contractor shall not rely on RMC's QA Representative to satisfy the requirements of these Specifications, except as it relates to the collection and analysis of post-excavation samples, which will be performed by the QA Representative.

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work

B. Section 01050 - Field Engineering

C. Section 02209 – Excavation/Handling/Placement

D. Section 01300 – Submittals

E. Section 02210 – Earthwork

F. Section 02751 – Cap Drainage Layer

G. Section 02755 – Cap Barrier Layer

H. Section 02936 - Site Restoration

1.3 DEFINITIONS

The following definitions pertain to requirements of this Section.

A. Quality Assurance (QA):

Quality Assurance is a planned and systematic pattern of activities (for example, approved surveillance and audit requirements) designed to assure and document that the Quality Control (QC) of items or procedures are being performed in accordance with the approved remedial design and that the product of the construction will perform satisfactory in service and will meet the highest quality standards. This Section also provides a methodology for resolving problems which may occur during construction. The Construction Quality Assurance Plan (CQAP) outlines the procedures and requirements for QA.

B. Quality Control (QC):

Quality Control is defined as those actions taken by manufacturers, fabricators, installers and contractors that provide a means (for example, through examining, witnessing, inspecting, checking and testing of in-process or completed work) to measure performance and to demonstrate that the characteristics of an item or service meet the contractual and regulatory requirements, as well as to document the results. Specific QC procedures and requirements are outlined in these Specifications. The Contractor performs Quality Control.

1.4 SUBMITTALS

A. The Contractor shall submit the names and qualifications of the personnel retained by the Contractor to conduct Quality Control activities. At a minimum this is expected to include geotechnical engineering testing services (i.e. compaction testing) and geomembrane installation quality control. If the geomembrane installation QC is conducted by the liner installer, the qualification of the installers QC representative shall be submitted with the liner installer company's qualifications.

1.5 SITE QUALITY CONTROL

A. The Contractor shall identify an individual within its organization at the site of the Work, who shall be responsible for overall management of Quality Control.

B. Material arriving at the site shall be inspected and documented to conform to the Contract requirements. Nonconforming and damaged material shall be segregated and removed from the site.

C. The Contractor shall protect all materials and equipment from rust, corrosion and similar damage.

D. The Contractor shall, as soon as the material arrives at site (but before beginning installation), provide to RMC the original bill of lading and required certifications stating that the material complies with the requirements of the Contract Documents.

E. The Contractor shall perform necessary and specified tests as received and shall document the results. The Contractor shall replace material that fails the tests.

F. Remove and replace new or existing material that is damaged in storage or in the performance of Work unless specifically accepted in writing by QA Representative.

G. No Work shall be performed at the Site if the Contractor's Superintendent, or his designee, is not present at the site.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

3.1 DATA MANAGEMENT AND DOCUMENTATION

A. General

The Contractor will be responsible for documenting that the quality control requirements of this project have been addressed and satisfied. The Contractor will be responsible for ensuring that the quality control documentation is complete and accurate with adequate documentation.

The Contractor's QC reporting will include descriptive remarks, data sheets, and logs to verify that the monitoring activities have been carried out in accordance with the Specifications and Construction Quality Control Plan. Performance standards established for the project will need to be demonstrated. The

Contractor will also maintain at the job site a complete file of plans and specifications, the Contractor HASP, the Contractor's checklists, test procedures, daily logs, and other pertinent materials that will be used to document conformance with the approved design drawings and specifications for this project.

The Contractor will prepare progress logs and test data sheets daily, as appropriate and provide such information as attachments to the Daily Field Reports. At a minimum, these reports will include the following information:

- Descriptions and locations of ongoing construction;
- Data on weather conditions;
- Equipment and personnel in each work area, including subcontractors;
- Descriptions and specific locations of areas, or units, or work being completed, tested and/or observed and documented;
- Locations where any tests and samples were taken; and a summary of tests results;
- Calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;
- Delivery schedule of relevant construction materials received, including quality control documentation for appropriate materials;
- Decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality; and,
- Signature.

The QA Representative will be made aware of any significant recurring non-conformance. The QA Representative will work with the Contractor to determine the cause of the non-conformance and recommend appropriate changes, such as revisions to procedures or specifications.

B. Design and/or Specification Changes

Design and/or specification changes may be required during construction. In such cases, the Contractor will notify RMC, who will coordinate with the Engineer regarding the nature of and reasons for the required change. Design and/or specification changes will be made only with the written agreement of RMC (following review and consultation with all appropriate parties such as the Engineer, USEPA and IDEM), and, if necessary, will take the form of an addendum to the Corrective Measures Design.

C. Contractor's Final QC Report

At the completion of the Work, the Contractor's Project Manager will submit to RMC a final QC report. This report will include:

- A certification that the Work has been performed in compliance with the Corrective Measures Design
- Physical sampling and testing have been conducted at the appropriate frequencies;
- Observation logs and testing data sheets including the Contractor's sample location plans; and
- As-Built drawings (See Section 01050).

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1: GENERAL

1.1 DESCRIPTION

A. Work included:

The Contractor shall provide temporary facilities and controls needed for the performance of its Work including, but not necessarily limited to:

1. Temporary utilities such as water, electricity, and telephone;
2. Field office for the Contractor's personnel;
3. Sanitary facilities;
4. Enclosures such as tarpaulins, barricades and canopies;
5. First-aid facilities;
6. Temporary fencing and other safety devices for pedestrian and vehicular traffic as well as isolating the construction area;
7. Entry Control limiting access to authorized construction personnel;
8. Dust and Pollution Control and Monitoring Equipment;
9. Erosion and Sediment Control;
10. Water Control;
11. Health and Safety measures as required by the Contractors approved Health and Safety Plan;
12. Creation and maintenance of access roads.

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work

B. Section 01300 - Submittals

C. Section 01351 – Health and Safety Plan Requirements

D. Division 2 of these Specifications

1.3 SUBMITTALS

A. The Contractor shall provide a plan showing the proposed layout for the temporary facilities for review and approval by RMC prior to start of mobilization.

1.4 PRODUCT HANDLING

The Contractor shall maintain and protect all temporary facilities and controls in proper and safe condition throughout progress of the Work.

1.5 TEMPORARY UTILITIES AND SERVICES

A. Water: Water lines are in place and operable up to the fire hydrant situated near pump house #4, although service has been discontinued. In order to perform the Work of the Contract, the Contractor shall be responsible for restoration of water service to the site prior to commencement of remedial activities and shall be responsible for discontinuation of water service following successful completion of remedial activities. The Contractor shall absorb all costs associated with water service restoration and cancelation, and the costs of the water usage during any phase of the Work of the Contract.

The Contractor shall also provide, maintain, and pay for potable water (e.g., bottled water) for each of the Contractor supplied office trailers and for all work personnel.

B. Sanitary Facilities:

1. The Contractor shall provide, and pay for all portable sanitary accommodations for all Contractor personnel on the project, including RMC representatives, and regulatory agencies. Facilities shall be located

in areas convenient to personnel and approved by RMC. The Contractor is to provide at least one portable sanitary unit per trailer and one unit shall be provided for every fifteen (15) employees of the Contractor. The units shall be cleaned and maintained by the Contractor in a sanitary condition and at a minimum frequency of twice per week.

C. Temporary Power and Lighting:

1. The Contractor shall provide all temporary electricity necessary to complete the Work as detailed in the Specifications and on the design drawings. The Contractor may connect to local electrical sources or may provide on-site generators; however, the temporary electrical supply method must be approved by RMC and must also meet federal, state, and local regulations. The Contractor's electrical service shall not be subject to voltage fluctuations capable of damaging electrical equipment.

2. The Contractor shall provide temporary lighting for the support (i.e., trailers), access, parking, and active work areas. The provision of lighting in the active work areas does not necessarily permit the Contractor to work after sunset without the prior written approval of RMC and the Engineer.

3. The Contractor shall pay all costs associated with the utility tie-ins, physical plant, maintenance of system throughout construction, power usage during the work, removal of same at project completion and any other items necessary in providing temporary power and light. The temporary power and lighting system shall at all times conform with the applicable codes and regulations of OSHA, NEMA, UL, and the local municipality.

D. Telephones:

1. The Contractor shall make necessary arrangements and pay costs for installation, maintenance and operation of direct line (non pay type) telephone services in the Contractor's field office at the site. Telephone service in main office trailer shall be suitable for conferencing during weekly progress calls.

1.6 ACCESS, STORAGE AND PARKING AREAS

A. The Contractor shall establish a construction Compound. The Contractor shall submit to RMC a plan layout of the Compound for RMC approval prior to mobilization.

B. The Contractor shall coordinate the provision of utility services for all trailers and be responsible for all installation charges, removal costs at Project completion, and any periodic or other charges incidental to the provision of those utility services.

C. Contractor shall provide lighting for the Contractor compound areas.

D. Routes of ingress and egress within the Site shall be clearly marked and protected by the Contractor as required by the Section 02100. Temporary roads to the construction areas shall be constructed and maintained by the Contractor. These roads may be extended and relocated as Work progresses, as long as traffic flow is unimpeded. The Contractor shall maintain both access and temporary construction roads in adequate condition such that vehicular and pedestrian traffic can safely and easily negotiate the roads. Conditions which should be corrected by the Contractor shall include, but are not be limited to, excessive ponding water, excessive dust generation, potholes, or excessive mud, snow, or debris. All access and temporary construction roads shall be removed and restored

E. Upon final acceptance of the Work, the Contractor shall clean up the work areas and leave them in a neat and orderly condition. The Contractor shall dismantle and remove all temporary fencing and barricades and other temporary items installed, unless otherwise directed by RMC. Repair damaged areas to their original condition.

1.7 FIELD OFFICES AND SHEDS

A. Contractor's Field Office:

Furnish and maintain a field office with a telephone at the site during the entire period of construction. Keep readily accessible at the field office copies of both the Contract Documents and the latest approved shop and working drawings.

B. RMC's Field Offices

The Contractor shall provide at least 100 sf of field office space for use by RMC's on-site representatives. Such space may be located in the same trailer as the Contractor's field office but must include a lockable door, desk surface with at least one 2-drawer file cabinet and two chairs.

1.8 ENCLOSURES AND TEMPORARY FENCING

A. The Contractor shall provide all storage necessary for materials and equipment associated with the Work, as specified in individual specification sections and as recommended by the respective manufacturers. Protection for materials, equipment, and completed Work shall be provided by the Contractor in addition to any special protection where specified in individual specification sections.

1.9 TEMPORARY SIGNAGE (CONSTRUCTION)

A. The Contractor shall provide, maintain, and pay for all barricades, temporary fencing, railings, warning lighting, signage and other similar items necessary to protect all areas required and to comply with OSHA guidelines for safe working environments for both site personnel and onlookers and to prevent unauthorized entry onto the Site or work zones.

1.10 PROTECTION OF NEW AND EXISITNG IMPROVEMENTS

A. The Contractor shall protect all areas on and off the Site that may be damaged by its activities. This shall include, but not be limited to, streets, roads, monitoring wells, Site entrances, existing fence and gates, railroad right-of-ways, existing drainage features, adjacent properties, previous site improvements, sidewalks, utilities, trees, plants, lawns or other maintained areas. The Contractor shall also protect all off-site and clean on-site areas from cross-contamination by vehicular tracking, erosion, or any other mechanism, manmade or natural. Any areas or items that are impacted by the Contractor's activities shall be repaired or replaced at the Contractor's expense.

B. Temporary and removable protection shall also be provided, as necessary. The Contractor shall control activity in the immediate work area to prevent damage or contamination. Traffic should be prohibited from completed or protected areas. Any damage to materials, equipment or completed Work shall be repaired or replaced at the Contractor's expense. The Contractor shall delineate work zones using temporary orange snow fence and posts with warning signs as approved by RMC and the Engineer.

1.11 POLLUTION AND DUST CONTROL

A. The Contractor shall supply all expertise, labor, equipment, and materials necessary to control the spread of contamination and to control the generation of excessive noise, dust or odor emissions. Dust control shall be conducted in order to maintain all work areas free from dust which would contribute to air pollution. Approved temporary methods of dust control consisting of sprinkling, water treatment, or similar methods will be permitted. Sprinkling, where used, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs.

B. The Contractor shall provide and maintain decontamination stations for the proper decontamination of all equipment, personnel, and materials leaving a contaminated work zone. This includes, but is not limited to, all pumps, power washers, storage tanks and Contaminant Reduction Zone.

C. The Contractor shall provide all necessary expertise, supervision, labor, materials, and equipment and shall perform all work activities in such a manner as to minimize the amount of noise, dust, or odor generated from the Site. The Contractor shall also ensure that the levels of noise, dust, and odor and methods of mitigating them are in accordance with federal, state and local regulations.

1.12 EROSION AND SEDIMENT CONTROL

A. The Contractor shall provide Erosion and Sediment controls as required by the Corrective Measures Design to protect the Site from erosion and to prevent contaminated particles from exiting the Site.

1.13 WATER CONTROL

A. The Contractor shall provide water control throughout the duration of the Contract in accordance with the Water Management During Construction Section 02715.

1.14 SECURITY

A. The Contractor shall be responsible for maintaining existing security fencing and gates for adequate protection of and restriction of access to all areas of the site, including support zones and active/inactive work areas, by unauthorized persons or vehicles throughout the Work. Security fence maintenance shall protect the Work and existing facilities from unauthorized entry, vandalism, or theft.

B. The Contractor shall be solely responsible for security of its equipment and work. RMC currently maintains a part-time security service consisting of one to three site visits by an unarmed guard between dusk and dawn. RMC does not maintain responsibility for protection of Contractor equipment, materials, or completed work.

1.15 PROGRESS CLEANING

A. The Contractor shall incorporate a cleaning program for the support facility and work areas of the Site on a periodic basis. The cleaning methods and frequency shall be adequate to maintain all areas of the Site, including maintaining the interior of trailers free of waste materials, debris, and rubbish, and generally safe, clean, organized and workable. Upon final acceptance of the Work, the Contractor shall clean up the work area and leave it in a neat and orderly condition.

B. The Contractor shall provide trash service involving at least one eight (8) cubic yard dumpster to be emptied once a week. The Contractor may need to provide more extensive trash collection measures during peak periods of construction so that the dumpster is not overflowing at any point in time.

1.16 FIRE PREVENTION CONTROL

A. The Contractor shall take all precautions necessary to prevent fires and explosions. All open flame, welding, and heating operations shall be performed in accordance with OSHA standards. The Contractor shall provide and maintain dry chemical type fire extinguishers in the immediate vicinity of any flame or spark producing operations and also in each of the office trailers. All flammable liquids shall be stored in accordance with OSHA standards. Gasoline shall be transported and stored in OSHA approved containers only.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

Not Used.

PART 4: MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Construction facilities and temporary controls shall not be measured.

4.2 PAYMENT

Mobilization shall include all expertise, supervision, labor, materials, and equipment necessary to be in accordance with this section of the Specifications, including establishment of the support zone. Progress payments will be made on a percent complete basis as determined by RMC. Mobilization shall be complete when Site preparation is being conducted at the rate shown in the Contractor's schedule.

PAY ITEM	UNIT
Mobilization	Lump Sum

END OF SECTION

SECTION 02720

SITE STORMWATER SYSTEM

PART 1: GENERAL

1.1 DESCRIPTION

This section covers work associated with the installation of the proposed storm water management basin outlet structures, culverts, flared end sections and outlet protection/rip rap aprons.

1.2 RELATED WORK

A. Section 01050 - Field Engineering

B. Section 01300 - Submittals

C. Section 01351 - Health and Safety Plan Requirements

D. Section 01400 – Quality Assurance/Quality Control

E. Section 02100 - Site Preparation

F. Section 02115 - Erosion and Sediment Control Measures

G. Section 02209 - Excavation/Handling/Placement

H. Section 02210 – Earthwork

I. Section 02936 – Site Restoration

1.3 DEFINITIONS

ASTM - American Society for Testing and Materials

CQAP - Construction Quality Assurance Plan

OSHA - Occupational Safety and Health Administration

1.4 QUALITY ASSURANCE

Quality Control activities for installation of the site storm water features shall be performed by the Contractor in accordance with the pipe manufacturer's installation requirements and relevant section of these specifications. Products used for construction of storm water systems, including piping materials, pre-cast-concrete structures, bedding materials and backfill shall comply with specific parameters contained in these Specifications. The QA representative will review the manufacturer's installation procedures and review Contractor's installation procedures for consistency therewith.

1.5 REFERENCES

ASTM A48 - Specification for Gray Iron Castings

ASTM D421 - Test Method for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants

ASTM D2487 - Procedure for Classification of Soils for Engineering Properties

1.6 SUBMITTALS

Contractor shall submit pipe manufacturers recommended installation procedures to QA Representative for review and approval.

1.7 PRODUCT HANDLING

All products required for construction of the proposed culvert and storm water management basin outlet structure shall be handled in accordance with manufacturers' recommendations.

PART 2: PRODUCTS

2.1 STRUCTURAL SOIL FILL

Structural soil fill shall be used for backfilling over and around pipes and structures associated with the site storm sewer system. Structural soil fill shall meet the requirements of the earthwork section of these specifications (Section 02210).

2.2 BEDDING

AASHTO #57 crushed stone shall be used for the Corrugated Polyethylene (CPE) pipe bedding, base support for inlet box and backfill where required.

2.3 PIPE

A. The Corrugated Polyethylene (CPE) pipe shall be ADS –12, fifteen (15)-inch diameter pipe or engineer approved alternate with bell and spigot joints, soil tight fittings.

B. Flared end sections shall be manufactured or approved for use with the CPE pipe and utilize compatible fittings.

2.4 INLET STRUCTURE AND TOP UNIT

A. Inlet structure utilized for the storm water management basin outlet structure shall be a precast concrete 2' x 4' inlet structure for use with designed piping (size and material specified in design) with matching concrete frame (without curb) constructed using minimum Class AA precast concrete. Inlet structure shall be placed on eight (8) -inches of AASHTO #57. Inlet structure shall have a medium duty cast gray iron grate compatible with proposed frame.

2.5 RIP-RAP

Stone utilized as rip-rap shall match the requirements for material size and type as required for Drainage Ditch Aggregate as described in Specification Section 02936.

PART 3: EXECUTION

3.1 PREPARATIONS

A. The Contractor shall have completed clearing and grubbing and rough grading for the containment cell berm, drainage ditch and perimeter access road.

B. Temporary storm water management measures shall be installed and fully operational for the purpose of collecting and managing storm water runoff from active work zones and disturbed site areas.

C. Railroad rail and ties shall be removed from the location where proposed storm water pipe will cross railroad spur.

3.2 INSTALLATION

A. Excavation and Bedding

1. The Contractor shall ensure that the trenches are excavated to the lines and grades as shown on the Drawings.

2. The trench shall be excavated in such a manner as to be safe for personnel to enter the trench for installation of the piping. OSHA and all other applicable regulations including the Health and Safety Plan shall apply to this and all site activities.

3. Material excavated from the trench and structure sub-base and not used as backfill shall be segregated for use as structural soil fill with approval from the QA Representative.

4. Construct 6-inch thick layer of bedding by placing the AASHTO #57 material in a single lift over the approved stable subgrade. If subrgade is unstable, section shall be over excavated to a stable bottom and backfilled with AASHTO #57. Compact with a mechanical tamper. Form a cradle in the bedding material for piping by means of a template conforming to the curvature of the outside surface of the bottom of the pipe to provide uniform contact under and around the pipe. A minimum of eight (8)-inches of bedding shall be placed beneath proposed structures.

B. Pipe Placement

1. The Contractor shall excavate and construct proposed pipe as detailed on the design drawings. Pipe installation shall be in accordance with manufacturer's recommendations. Lay pipe in the cradle formed as specified above with bells up grade. Begin and end pipe at flared end sections or inlet structures as shown on drawings.

2. Control the pipe alignment and grade with suitable string lines, with an electronic laser beam system, or by other acceptable methods. Laser must be utilized for slopes less than two (2) percent.

3. Provide one (1)-foot minimum cover over the top of pipe for the storm sewer pipe.

4. Backfilling may proceed immediately after placement maintaining pipe in proper alignment and grade.

5. When pipes are connected with pre-cast concrete structures, cut off exposed pipe ends flush with the structure face and finish the inside and outside voids between the pipe and the precast opening with mortar.

C. Backfilling

Backfill shall be placed in lifts and compacted by the Contractor according to the requirement of Section 02210.

3.3 OUTLET PROTECTION

A rip rap apron (4 feet wide x 4 feet long x 9 inches thick shall be constructed at both the up-slope and down-slope flared end sections. The subbase for the rip-rap apron shall be lined with geotextile fabric.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 02751

CAP DRAINAGE LAYER

PART 1: GENERAL

1.1 DESCRIPTION

The Work covered by this section includes installation of the cap drainage layer for the containment cell cap systems. This includes manufacture, fabrication, packaging, delivery, and installation of all components. Specific components include the composite drainage layer (geonet/geotextile composite), perforated anchor trench drain, granular fill, and geotextile.

1.2 RELATED SECTIONS

A. Section 01050 - Field Engineering

B. Section 01300 - Submittals

C. Section 02210 - Earthwork

D. Section 02755 - Cap Barrier Layer

1.3 REFERENCES

ASTM D413 -	Test Method for Rubber Property-Adhesion to Flexible Substrate
ASTM D422 -	Test Method for Particle-size Analysis of Soils
ASTM D1682 -	Test Method for Strip Tensile Strength
ASTM D2487 -	Procedure for Classification of Soils for Engineering Purposes
ASTM D3776 -	Test Method for Mass per Unit Area (Weight) of Fabric
ASTM D4354 -	Standard Practice for Sampling of Geosynthetics for Testing
ASTM D4533 -	Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4595 -	Test Method for Tensile Properties of Geotextiles by the Wide Width Strip Method
ASTM D4632 -	Test Method for Breaking Load and Elongation of Geotextiles (Grab Method)
ASTM D4716 -	Test Method for Constant and Hydraulic Transmissivity of Geotextiles and Geotextile Related Products
ASTM D4751 -	Test Method for Determining Apparent Opening Size of a Geotextile

ASTM D4759 -	Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4833 -	Test Method for Index Puncture of Geotextiles, Geomembranes and Related Products
ASTM D5321 -	Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

1.4 SUBMITTALS

A. The Contractor shall submit Manufacturer's literature and specification for perforated piping to the QA Representative for approval. A minimum of four weeks prior to cap installation, the Contractor shall submit Manufacturer's specifications and physical property information for the composite drainage layer to the QA Representative for approval.

B. The Contractor shall have a geosynthetics testing laboratory perform shear box testing pursuant to ASTM D5321, for the soil/composite interface, composite/geomembrane interface, geomembrane/geotextile interface and geotextile/soil interface and shall include the results with the submittal for approval by QA Representative prior to delivery of materials to the site. Shear box testing shall be run at 3 psi, 1.5 psi, and 0.5 psi using site specific materials.

1.5 STORAGE

The composite drainage layer rolls delivered to the project site shall be stored in their original, unopened wrapping in a dry area and protected from precipitation and the direct heat of the sun. The materials shall be stored above the ground surface and beneath a roof or other protective covering.

1.6 QUALITY ASSURANCE

Quality assurance of geosynthetic installation shall be performed in accordance with the Construction Quality Assurance Procedure.

PART 2: PRODUCTS

2.1 GEONET

A. The geonet shall be a high density polyethylene (HDPE) material with intersecting material strands creating a three dimensional structure which supports planner water flow.

B. The geonet shall conform to the following requirements or the manufacturers minimum published values, whichever is more restrictive:

Properties	Test Method	Required Value
Transmissivity (M^2/S), min.	ASTM D4716 i = 1.0 Φ = 2000 psf	1.4×10^{-3}
Tensile Strength (lb/in), min.	ASTM D1682 or D4595	22

C. Contractor shall provide conformance testing as required by Construction Quality Assurance Plan.

2.2 PIPE

The pipe used within the perimeter cap drainage system (where required) shall be a six (6)-inch perforated corrugated polyethylene tubing (Class 2 Perforations) meeting the requirements of AASHTO M25-94. The pipe shall include all appropriate connections and end protection recommended by the manufacturer and as shown on the design drawings.

2.3 GEOTEXTILE

A. The geotextile bonded to the geonet shall be a non-woven material conforming to the following requirements. Geotextile shall be heat bonded to the geonet and extend a minimum distance of 6-inches beyond the geonet at either end of the cross machine direction.

Properties	Test Method	Required Value
Grab Strength (lbs.), min.	ASTM D4632	150
Puncture Strength (lbs.), min.	ASTM D4833	75
Tear Strength (lbs.), min.	ASTM D4533	70
Mass per Unit Area (oz/sy), min.	ASTM D3776	8
Apparent Opening (US sieve No.)	ASTM D4751	80
Ply Adhesion (lbs/in)	ASTM D413	1.0

B. The geotextile wrap used for the cap edge drains shall meet the same minimum requirements but will not be bonded to the geonet.

2.4 PEA GRAVEL FILL

Pea gravel fill shall be used as drainage material around the piping system for the perimeter cap drain and the cap edge drain. Granular fill shall be clean, rounded material with particles not larger than 1-1/2-inch in diameter and no greater than 5 percent fines (pea gravel).

2.5 INTERFACE FRICTION

Shear box testing shall be performed at confining pressures of 0.5, 1.5 and 3.0 psi. Shear box test results shall demonstrate that the composite drainage layer and geomembrane have the following values:

Cover Soil/geotextile of composite	22° min.
Geotextile of composite/textured geomembrane	22° min.
Textured geomembrane/geotextile	22° min.
Geotextile/soil	22° min.

Lower interface friction values may be approved by the Engineer if finished slopes on the Containment Cell are less than 3 horizontal:1 vertical.

PART 3: EXECUTION

3.1 GENERAL

A. The work shall be coordinated with placement of the HDPE geomembrane and anchor trench backfill. The cap drainage layer shall be placed directly above the HDPE geomembrane.

B. Prior to placement of the cap drainage layer, the portion of the geomembrane to be covered by the geonet/geotextile composite shall have all required documentation complete. The surface of the geomembrane shall not contain stones or excessive dust that could cause damage.

C. The composite drainage layer shall be cut, if necessary, using an approved cutter. Care must be taken to protect underlying geomembrane if the geonet or geotextile is being cut in place.

D. Equipment used to deploy the composite drainage layer shall not damage the materials or the underlying geomembrane.

3.2 COMPOSITE DRAINAGE LAYER

A. The Contractor shall keep the composite drainage layer clean and free from debris. Soils and debris shall be cleaned by the Contractor just prior to installation, as determined by QA Representative. The Contractor shall handle all rolls in a manner to ensure they are not damaged in any way. To prevent folds and wrinkles, tension should be kept on the materials. Materials shall not be placed across side slopes. Geotextile side of the composite shall be placed facing up.

B. In the presence of winds, the composite drainage layer shall be weighted with sandbags, as necessary. The Contractor shall be responsible for damage caused by wind.

C. Adjacent geonet rolls shall be overlapped at least 6-inches and secured by plastic ties approximately every three (3) feet along the roll length. Plastic ties shall be white or another bright color for easy inspection. Metallic ties shall not be allowed. The heads of the ties must fit completely into the geonet channel space so that the head of the tie does not intrude into or against the primary liner. Adjacent pieces of composite drainage layer shall have their top geotextile components lystered together after the geonet is connected and accepted by QA Representative.

D. Horizontal seams shall not be placed on side slopes greater than 5% unless approved by QA Representative in the panel placement plan.

E. Repair

Patching of the composite shall be used to repair holes, tears, and defects. Patches shall provide 6" of overlap around the repaired area and shall be held in place with plastic ties. Composite shall be removed if areas with large defects are observed. QA Representative shall determine the acceptability of the composite drainage layer.

3.3 DRAINAGE LAYER EDGE DRAIN

A. The six (6)-inch diameter perforated polyethylene pipe shall be placed in the anchor trench following placement of the cap geomembrane and geotextile wrap. The Contractor shall place the pipe in a manner which ensures underlying materials are not damaged. Edge drain shall be continuous with outfalls located no greater than 200 ft apart. Details of the pipe can be seen on Sheet 11.

B. Pea gravel fill shall be placed around the pipe for drainage. Pea gravel fill shall be placed by the Contractor in a manner which ensures surrounding materials are not damaged. Pea gravel fill shall be placed to provide proper support for the overlying trench backfill. The QA Representative shall monitor fill placement.

3.4 OUTFALLS

Cap drain outfalls shall be installed at the locations shown on Sheet 5 and in accordance with the detail on Sheet 11.

PART 4: MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Measurement for payment for the composite drainage layer will be based on the actual number of square yards of covered surface area in-place.

The cap drainage layer edge drain shall be measured as lineal feet in-place and shall include required granular fill, perforated pipe, pipe fittings, geotextile and cap drain outfalls.

Granular fill will not be measured and will be considered incidental to pipe placement.

4.2 PAYMENT

All prices shall include, but will not be limited to, submittals, testing, material manufacture, packaging, delivery, and storage; deployment, patches, seams, overlaps, repairs; and cleanup.

All work associated with furnishing and hauling material will not be paid separately but shall be included in the work required, or as approved by the Resident Engineer. No additional payment will be made for removing approved materials which are rendered unsuitable after placement or replacement or for removal, hauling, disposal and replacement of objectionable materials.

The completed work as measured for the cap drainage layer shall be paid for according to the unit price schedule.

PAY ITEM	PAY UNIT
Composite Drainage Layer	Square yard
Edge Drain (complete)	Linear foot
Edge Drain Outfall	Each

END OF SECTION

SECTION 02755

CAP BARRIER LAYER

PART 1: GENERAL

1.1 DESCRIPTION

The Work covered by this section includes furnishing the materials, equipment, labor and expertise required to supply, fabricate and install the high density polyethylene liner (HDPE) component of the containment cell cap barrier layer and the underlying non-woven geotextile.

1.2 RELATED SECTIONS

A. Section 01050 - Field Engineering

B. Section 01300 - Submittals

C. Section 01351 - Health and Safety Plan Requirements

D. Section 02210 - Earthwork

E. Section 02715 - Water Management During Construction

F. Section 02751 - Cap Drainage Layer

1.3 REFERENCES

ASTM D638 - Test Method for Tensile Properties of Plastics

ASTM D746 - Test Method for Brittleness Temperature of Plastics and Elastomers by Impact

ASTM D792 - Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement

ASTM D1004 - Test Method for Initial Tear Resistance of Plastic Film and Sheeting

ASTM D1204 - Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature

ASTM D1238 - Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer

ASTM D1505 -	Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603 -	Test Method for Carbon Black in Olefin Plastics
ASTM D1682 -	Test Method for Strip Tensile Strength
ASTM D1693 -	Test Method for Environmental Stress Cracking of Ethylene Plastics
ASTM D2663 -	Test Method for Rubber Compounds-Dispersion of Carbon Black
ASTM D3015 -	Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds (NSF Modified)
ASTM D4354 -	Standard Practice for Sampling of Geosynthetics for Testing
ASTM D4437 -	Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
ASTM D4533 -	Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4595 -	Test Method for Tensile Properties of Geotextiles by Wide Width Strip Method
ASTM D4716 -	Test Method for Constant Head Hydraulic Transmissivity of Geotextiles and Geotextile Related Products
ASTM D4759 -	Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4833 -	Test Method for Index Puncture of Geotextiles, Geomembranes and Related Products
ASTM D5084 -	Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter
ASTM D5321 -	Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

GRI Test Method GM6 - Pressurized Air Channel Test for Dual Seamed Geomembranes
NSF Standard 54(1991) Flexible Membrane Liners

1.4 SUBMITTALS

A. Bid Submittal

The Manufacturer and Contractor shall submit proof of qualifications with bid documents. These Submittals shall include the following:

1. Manufacturer: The Manufacturer shall submit a Quality Control Manual, a list of material properties, and a list of completed facilities totaling 5,000,000 square feet (list should specify facility name, location, date of installation, owner name, designer, Contractor, as well as the name and telephone number of a contact at the facility who can discuss the project).

The manufacturer shall also provide a minimum ten (10) year material warranty.

2. Contractor: The Contractor shall submit certification that the Installation Supervisor and Master Seamer have reviewed the Construction Drawings, the Construction Quality Assurance Plan and these Specifications. The Contractor shall also submit a copy of the Manufacturer's approval letter or license, qualifications resumes for the Installation Supervisor and Master Seamer, proposed seaming method descriptions, detailed quality control procedures and a list of completed facilities totaling 1,000,000 square feet each of polyethylene geomembrane (list should specify facility name, location, Manufacturer, date of installation, designer, and the name and telephone number of a contact at the facility who can discuss the project).

B. Post-Contract Award Submittal

After the contract award, the geomembrane Contractor shall submit a Panel Layout Plan to the QA Representative for approval. This plan shall be submitted at least two weeks prior to delivery of the geomembrane to the site.

C. Interface Testing Submittal

The Contractor shall have an independent geosynthetics testing laboratory perform shear box testing pursuant to ASTM D5321 for the interfaces and confining pressures identified in Section 02751.

1.5 PRODUCT HANDLING

Transportation and handling of the geomembrane shall be the responsibility of the Contractor. The Contractor shall provide all necessary equipment and assure that personnel are properly trained for handling of the geomembrane. Geomembrane rolls shall be stored in an area which provides protection from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, or any other damage. Seriously damaged rolls, as determined by QA Representative, shall be rejected.

The geomembrane shall not be folded. Folded material shall be rejected.

1.6 QUALITY ASSURANCE

Quality assurance of geomembrane installation shall be performed in accordance with the enclosed Construction Quality Assurance Plan.

PART 2: PRODUCTS

2.1 RAW MATERIAL

The geomembrane shall be produced from raw materials, which may include the polymer resin, plasticizer, fillers, anti-degradants and processing aids. The resin used in production of the HDPE geomembrane shall meet the following requirements:

TEST	METHOD	REQUIREMENT	NOTES
SPECIFIC GRAVITY	ASTM D1505	>0.940	1 & 2
MELT INDEX	ASTM D1238	<0.4 g/10 min.	1 & 2 (Condition E Max)
CARBON BLACK CONTENT	ASTM D1603	2 to 3%	2

(1) Measure prior to adding carbon black.
(2) Test shall be performed at a rate of at least 1 per resin batch.

2.2 GEOMEMBRANE ROLLS

A. The geomembrane used at the site shall be a textured 60 mil high density polyethylene (HDPE). HDPE rolls shall meet the following requirements:

1. Condition: The geomembrane surface shall not have striations, roughness, pinholes, bubbles, staple marks, folds, or any other damage.

2. Properties: The geomembrane, as delivered to the site, shall meet the following physical and index property requirements or the manufacturer's minimum published values, whichever is more restrictive. Adherence to this requirement shall be made a condition of the material purchase order:

Required Material Properties of HDPE

Properties	Test Method	60 mil textured
Thickness (mils), max.	ASTM D1593	57
Density (g/cc), max.	ASTM D792 or D1505	0.940
Tensile Properties	ASTM D638-NSF Modified	
1. Strength at Yield (lb/in. width) min.		126
2. Strength at Break (lb/in width), min.		90
3. Elongation at Yield (percent), min.		12
4. Elongation at Break (percent), min.		100
Tear Resistance (lb), min.	ASTM D1004	39
Dimensional Stability	ASTM D1204	+/-2.0
(% change), max.	100°C, 1 hr	
Puncture Resistance (lbs)	ASTM D4833	72
Carbon Black Content (%), range	ASTM D1603	2.0-3.0
Carbon Black Dispersion	ASTM D3015-NSF Modified	A1, A2

* Values obtained from NSF International Standard 54 Flexible Membrane Liners

2.3 EXTRUDATE BEADS AND/OR ROD

All extrudate shall be compatible with the HDPE geomembrane specified. Extrudate shall be from the same Manufacturer and of the same resin type as the geomembrane rolls.

2.4 GEOTEXTILE

The geotextile to be placed beneath the geomembrane on top of the soil shall be a non-woven material conforming to the following requirements.

Properties	Test Method	Required Value
Grab Strength (lbs.), min.	ASTM D4632	200
Puncture Strength (lbs.), min.	ASTM D4833	100
Tear Strength (lbs.), min.	ASTM D4533	80
Mass per Unit Area (oz/sy), min.	ASTM D3776	8

PART 3: EXECUTION

3.1 PREPARATION

Contractor and QA Representative shall inspect the surface of the stabilized soil prior to placement of the geotextile. The surface shall be dry, and free of sharp stones or protruding objects. The surface have been roughed using raking or other methods acceptable to the QA Representative.

3.2 GEOMEMBRANE ROLL CONFORMANCE

The Contractor shall have an independent laboratory perform confirmatory testing of the HDPE geomembrane rolls. Test shall include density (ASTM D792 or D1505, thickness (ASTM D1593), tensile characteristics (ASTM D638-NSF Modified), tear resistance (ASTM D1004), dimensional stability (ASTM D1204) and carbon black content (ASTM D1603). A roll shall be considered a production unit and a shipment to the site shall be a lot. Conformance shall be determined in accordance with ASTM D4759 once for every 100,000 sf of material installed.

3.3 GEOMEMBRANE AND GEOTEXTILE PLACEMENT

A. Panel Layout

1. A field panel is the unit area of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of a roll cut in the field.

2. At least four (4) weeks prior to construction, the Contractor shall provide the QA Representative with drawings of the area to be covered showing the orientation of all geotextile and geomembrane panels (i.e., panel layout plan). In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across, the slope. Whenever possible, horizontal seams shall be located not less than five (5) feet from the toe of slope. In corners and odd-shaped geometric locations, the number of field seams shall be minimized.

3. Each panel shall be given an "identification code" (numeric or alpha-numeric) consistent with the layout plan. This identification code shall be agreed upon by the Contractor and QA Representative. The code shall be as simple and logical as possible. Identification codes shall be used for all project records.

4. Each seam shall be given an identification code consistent with the layout plan. The seam identification system should differentiate between seam types, where possible. The seam identification system shall be compatible with the panel numbering system. The identification codes shall be used for all project records.

B. Panel Placement

1. QA Representative shall verify that panels are installed at the locations indicated in the Contractor's layout plan, as approved or modified.

2. Geotextile panels shall be installed from top of slope and adjoining panels shall be sewn together. Geotextile panels shall be installed one at a time and each panel shall be seamed immediately after its placement. Adjacent panels shall be overlapped a minimum of twelve (12) inches. The sewn seam shall consist of a prayer stitch with nylon thread. Geomembrane placement shall follow immediately behind geotextile deployment. QA Representative may allow placement of additional panels; however, all panels placed must be seamed and properly anchored by the end of the

day. The geotextile shall not be allowed to get wet. QA Representative shall record the roll number, identification code, location and date of installation for each geomembrane panel placed.

3. The Contractor shall advise the QA Representative and the RMC of any and every change in the schedule.

4. Geomembrane placement shall not proceed at an ambient temperature below 0°C (32°F) or above 40°C (104°F). Ambient temperature shall be measured approximately one (1) foot above the liner. Placement shall not be performed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds. QA Representative shall be the sole judge as to whether or not placement conditions are acceptable. QA Representative shall also verify that the subgrade has not been damaged by adverse weather conditions.

C. Geosynthetic Handling - The Contractor shall assure the following during placement:

1. Any equipment or tools used shall not damage the geotextile or geomembrane by handling, trafficking, leakage of hydrocarbons, or other means.

2. No personnel working on the geotextile or geomembrane shall smoke, wear damaging shoes, or engage in other activities which could damage the materials.

3. The method used to unroll the materials shall not cause scratches, crimps, cracks, or breaks in the geomembrane and shall not damage the geotextile.

4. The method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels). If warranted, intentional wrinkling of the geomembrane to compensate for expansion/contraction is allowable. Locations and dimensions of these wrinkles shall be detailed by the Contractor on the Geomembrane Layout Plan submitted to QA Representative.

5. Depressions in the compacted subgrade causing bridging by the geosynthetic cap components shall be removed or leveled by the Contractor.

6. Adequate temporary loading (e.g., sand bags) not likely to damage the geosynthetics shall be placed to prevent wind uplift.

7. Direct contact with the geomembrane shall be minimized; i.e., the geomembrane in traffic areas shall be protected by geotextiles, extra geomembrane, or other suitable materials approved by QA Representative.

D. Inspection of deployed panels:

1. QA Representative and Contractor shall inspect each panel for damage immediately after placement, but prior to seaming. Panels which are seriously damaged shall be rejected, while panels with minor damage may be allowed.

2. QA Representative shall be the sole judge as to whether panels are acceptable or must be removed. QA Representative shall record all damages and advise the Contractor as to which panels, or portions of panels, shall be rejected, repaired, or accepted.

3. Damaged panels or portions of damaged panels which have been rejected shall be marked and removed from the site by the Contractor at his own cost.

4. Repairs shall be made according to procedures described in this specification or according to Manufacturer's procedures, as approved by QA Representative.

E. Field Seaming

1. The Contractor shall ensure that adjacent panels of geomembrane are overlapped by a minimum of four (4) inches. Seams aligned across the slope shall be overlapped such that the upslope panel lies over the downslope panel.
2. Seam Preparation - Prior to seaming, the following procedures shall be followed:

   a. The seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign matter. Brush and wash the seam overlap portion of each panel as necessary to ensure clean contact between the panels.

b. Rolls must be laid out with no tension so that seams are aligned without wrinkles and "fishmouths".

c. For extrusion welding, grinding of the geomembrane shall be done with a hand held rotary grinder having 80 grit or finer sandpaper. Grinding shall be perpendicular, not parallel, to the seam. Overgrinding shall be avoided.

3. Weather Conditions - The following weather restrictions apply to seaming operations:

a. Seaming shall not take place during any precipitation, in the presence of excessive moisture (i.e. fog, dew, frost), in an area of ponded water or in the presence of excessive winds (unless wind barriers are provided).

b. Seaming may proceed if the geomembrane sheet temperature is above 32°F (0°C) if it can be proven via test strips that quality seams can be fabricated at lower temperatures. QA Representative shall determine the acceptability of cold weather seaming. A movable protective layer may be required below each seam overlap to prevent moisture buildup due to condensation during seaming.

c. Seaming may proceed if the sheet temperature is above 122°F (50°C) if it can be proven via test strips that quality seams can be fabricated at higher temperatures. QA Representative shall determine the acceptability of hot weather seaming. Sheet temperature should be measured by an infrared thermometer or surface contact thermocouple.

4. Test seams shall be made each day by the Contractor prior to commencing field seaming. Test seams shall be performed for each seamer working that day. These seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are acceptable. Such test seams shall be at startups and at least once every four hours, or at the discretion of QA Representative. A field tensiometer shall be used by the Contractor to determine the peel and shear of test seams in accordance with ASTM D4437-NSF modified for 5 peel and 5 shear coupons. QA Representative shall determine the acceptability of test seams. If test seams are determined to be inadequate, appropriate corrective actions shall be taken.

5. Geomembrane seaming shall be performed by extrusion welding, extrusion flat wedge welding and/or hot wedge welding.

3.4 TESTING

A. Non-Destructive Seam Continuity Testing

1. The Contractor shall non-destructively test all field seams over their full length. The purpose of this testing is to verify seam continuity. Testing shall be done as the seaming work progresses. In addition, the Contractor shall record location, date, seam number, name of tester, and outcome of all testing. QA Representative shall monitor non-destructive seam testing.

2. The Contractor shall complete any required repairs in accordance with this specification. If repairs are required, the Contractor shall mark on the geomembrane that the repair has been made and shall document the results of non-destructive testing on the repair.

3. The following procedures shall be implemented by the Contractor at locations where seams cannot be non-destructively tested:

   a. If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation.

   b. If the seam cannot be tested prior to final installation, acceptable seaming and cap-stripping operations shall be agreed upon between QA Representative and Contractor regarding uniformity and completeness. All such seams shall be cap-stripped with the same geomembrane.

4. Non-destructive seam testing shall be performed using either a vacuum box in accordance with ASTM D4437 or pressurized dual seam testing as outlined by GRI Test Method GM6. Other non-destructive test methods may be used, as approved by QA Representative.

B. Destructive Seam Strength Testing

1. The Contractor shall have an independent laboratory destructively test field seam samples. The purpose of this testing is to verify seam integrity.

The Contractor shall provide QA Representative with verbal results within 48 hours after seam sampling.

2. The Contractor shall submit to QA Representative one destructive seam sample per 500 feet of seam length. The exact sample location shall be selected by QA Representative. Individual samples may be taken at greater or lesser intervals. Additional destructive samples may be taken, at the discretion of QA Representative, in areas of excess crystallinity, offset welds, areas of contamination, or other visible discontinuities.

3. The sample cut shall be eighteen (18) inches wide by thirty-six (36) inches long with the seam centered lengthwise. The sample shall be cut into thirds; one section for the Contractor and two sections for QA Representative. Samples shall be cut by the Contractor under the observation of QA Representative.

4. QA Representative shall be responsible for destructive testing to assure seam integrity. Seams shall be tested by an independent laboratory for shear strength and peel adhesion. The following properties shall be required of an acceptable seam:

TEST	TYPE OF BREAK	REQUIRED STRESS
Shear Strength	FTB greater than 100% elongation ASTM 4437-NSF Modified	100 lb/in, min.
Peel Adhesion	FTB less than 30% separation ASTM 4437-NSF Modified	75 lb/in, min. (Fusion)

5. Ten one (1)-inch wide replicate specimens shall be cut from the twelve (12)-inch wide sample. Five specimens shall be tested for shear strength and five for peel adhesion. All specimens must meet minimum strength requirements and at least four of the five samples for each test must fail outside of the seam area and meet the aforementioned requirements.

6. All holes in the geomembrane resulting from seam sampling shall be immediately repaired. Patches shall be vacuum tested to assure continuity.

7. The following procedures shall apply whenever a seam sample fails a destructive test. The Contractor has two options:

   a. Reconstruct the seam between the failed location and any passed test location.

   b. Retrace the welding patch to an intermediate location (at a minimum distance of ten (10)-feet from the failed test location) and take a eighteen (18)-inch by twelve (12)-inch sample for an additional destructive seam test. If this sample passes the destructive seam test, then the seam shall be reconstructed or cap stripped between the passed locations. If this sample fails, then the process shall be repeated.

   c. Cap strip the seam between the failed location and the closest adjacent passing test location.

   d. In any case, all acceptable reconstructed seams shall be bounded by two passed test locations (i.e., the above procedure shall be followed in both directions from the original failed location). For long lengths of reconstructed or cap stripped seam, QA Representative shall take additional destructive seam samples.

3.5 DEFECTS AND REPAIRS

A. All seams and non-seam areas of the geomembranes shall be evaluated by the Contractor and QA Representative for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection. The geomembrane surface shall be broomed or washed by the Contractor if the amount of dust or mud inhibits inspection.

B. Each suspect location in seam and non-seam areas shall be non-destructively tested using the methods detailed in this specification. Each location which fails non-destructive testing shall be marked and repaired by the Contractor. QA Representative shall verify markings and repairs.

C. Repair procedures are as follows:

   1. Defective seams shall be repaired by reseaming or applying a cap strip.

2. Tears or pinholes shall be repaired by extrusion welding or patching.

3. Blisters, larger holes, undispersed raw materials, and areas contaminated by foreign matter shall be repaired by patches.

4. Cap strips shall be at least six (6) inches wide and must be centered over the repair location. Cap strips shall be of the same material as the geomembrane.

5. Patches shall be round or oval in shape, made of the same materials as the geomembrane, and extend a minimum of six (6) inches beyond all edges of the defect. Patches shall be applied using extrusion fillet welding or other technique approved by QA Representative.

6. Repairs shall be numbered and logged by QA Representative and Contractor. Logging shall include repair type, welding machine used, welder, location, date of repair and details of non-destructive and/or destructive seam evaluation.

D. Each repair shall be evaluated using non-destructive testing, as described in this specification. Repairs which pass non-destructive testing shall be considered adequate. Repairs which fail non-destructive testing shall be redone and retested until a passing test is achieved. Destructive testing of long lengths of cap strips shall be performed as determined by QA Representative.

3.6 GEOMEMBRANE ACCEPTANCE

A. The Contractor shall retain all ownership and responsibility for the geomembrane until acceptance by RMC. The geomembrane shall be accepted by RMC when all of the following apply:

1. Geomembrane installation is finished.

2. All required documentation of installation is completed by the Contractor and QA Representative's certification report is completed.

3. Material conformance and destructive seam testing is completed.

4. Verification of the adequacy of all field seams and repairs, including associated testing, is completed.

5. The Contractor shall provide a final certification stating that installation has proceeded in accordance with the project specifications.

6. Written certification documents, including as-built drawings, sealed by a registered professional engineer have been received by RMC.

3.7 QUALITY ASSURANCE FOR CONTAINMENT CELL CAP SYSTEM

A. Raw Material (HDPE)

The geomembrane manufacturer is responsible for the production of geomembrane rolls from resin. Upon delivery, the following shall be furnished by the manufacturer:

1. The original resin supplier's name, resin production plant, identification (brand name/number), and productive date of the resin.

2. A copy of the quality control certificates issued by the resin supplier, noting results of density and melt index.

3. Reports on tests performed by the manufacturer to verify the quality of the resin used in the geomembrane and geonet rolls assigned to the RMC site meet the project specifications.

B. Product Certifications

The Contractor shall submit certification that all geomembrane, geotextile, and geonet rolls brought to the site meet the requirements of the specifications. For each material used at the site, the Contractor shall provide the following to QA Representative:

1. A properties sheet including specified properties and testing methods.

2. The base polymer descriptions.

3. Testing results and sample procedures from quality control testing.

4. A certification that property values given in the properties sheet are guaranteed by the manufacturer.

5. Statement certifying that no reclaimed polymer is added to the resin. Product run may be recycled, but shall only be at a proportion of 2 percent of the batch by weight.

6. Geosynthetic delivery, storage, and handling instructions.

One quality control certificate for every roll of geosynthetic used shall also be provided to QA Representative by the Contractor. This certificate shall include roll numbers and identification. The finished rolls shall be identified by a number corresponding to the particular batch of resin used. QA Representative will review all certificates for compliance with the project specifications.

The following information shall also be provided by the Contractor for any extrudate used for the project:

1. Statement of production date(s).

2. Certification stating that all extrudate is from the same manufacturer and is of the same resin type as the geomembrane seamed.

3. Copy of quality control certificates issued by the manufacturer.

C. Transportation and Handling

Geosynthetic rolls or panels shall be packaged and shipped by appropriate means so that no damage is caused.

The Contractor shall complete a Material Delivery Report (Form 1)

D. Subgrade Acceptance

1. Immediately prior to installation of the geotextile, the subbase surface shall be observed by QA Representative, Installer and Contractor. The decision to repair ruts or depressions, if any, shall be made by QA Representative. The Contractor shall repair any unacceptable subbase.

2. All recommendations and work performed on the subbase prior to installation shall be recorded. No geomembrane shall be placed on surfaces not previously found acceptable to QA Representative.

3. Surfaces to be lined shall be smooth, and free of debris, roots, and angular or sharp stones larger than 2-inch. The subbase surface shall be free from organics, trash, clayballs, sharp stones or any other deleterious material. The subbase shall be compacted in accordance with the design specifications but in no event below the minimum required to provide a firm unyielding foundation sufficient to permit the movement of vehicles and welding equipment over the subbase without causing rutting. The subbase shall have no sudden or abrupt changes in grade.

E. Anchor Trench

1. The anchor trench shall be excavated to the line, grade, and width shown on the construction drawings, prior to geosynthetic placement. The Contractor shall verify that the anchor trench has been constructed according to the project drawings.

2. The anchor trench shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled by the Contractor after installation of the geotextile, geomembrane, drainage layer and perforated polyethylene pipe, as outlined in the project specifications.

F. Geomembrane Installation

1. Immediately prior to installation of the geomembrane, QA Representative shall observe the geotextile surface to insure that it is smooth, dry and free of creases, lumps and foreign objects.

2. Welding shall not take place during any precipitation, in the presence of excessive moisture, i.e., fog, dew, frost, in an area of ponded water or in presence of excessive winds (unless wind barriers are provided).

3. Seaming may proceed if the geomembrane sheet temperature is above 32°F (0°C), or if it can be proven via test strips that good seams can be fabricated at lower temperatures. QA Representative shall determine the acceptability of cold weather seaming. Sheet temperature should be measured by an infrared thermometer or surface contact thermocouple.

4. The Contractor shall be responsible for the following:

a. No equipment or tools shall damage the membrane by handling, trafficking, or other means.

b. No personnel working on the lining system shall smoke, wear damaging shoes, or engage in other activities that could damage the geosynthetics.

c. The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil.

d. The method used to place geomembrane panels shall minimize wrinkles. Wrinkles shall be identified as to proper location by the Installer and shall be shown on the Contractor's As-Built drawings. Ballast shall be used to prevent relocation of the compensating wrinkles by wind.

e. Bridging shall be removed.

f. Adequate loading (i.e., sandbags) shall be placed to prevent uplift by wind. (In case of high winds, continuous loading is recommended along the edges of panels to minimize risk of wind flow under the panels).

g. Direct contact with the geomembrane shall be minimized, i.e., the geomembrane in traffic area is to be protected by geotextiles, extra geomembrane, or other materials approved by QA Representative.

5. A field panel is the unit area of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of a roll cut in the field. Each field panel shall be given an "identification code" consistent with the layout plan. This code should be as simple and logical as possible.

6. Field panels are installed at the locations indicated by the layout plan. Each panel placement should be recorded immediately using the daily deployment report. Identification code, location and date shall be recorded. Form 2, or a comparable equivalent, shall be used by the Contractor to evaluate panel thickness and as a record of daily deployment. All panels that are folded shall be replaced by the Installer.

7. Field Seaming

   a. The welding or seaming procedure consists of overlapping the two geomembrane sheets such that any water flowing across the seams would flow from the top panel to the underlying panel.

   b. Longitudinal seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. In corners and odd shaped geometric locations, the number of field seams should be minimized.

   c. Seams shall be aligned with the least possible number of wrinkles and "fishmouths". If a "fishmouth" or wrinkle is found, it shall be cut, removed and patched.

   d. Details of each seam, including seamer, machine number, time, and temperature shall be recorded by the Contractor on the Pre-Weld and Geomembrane Seaming Record (Form 3).

8. Pre-Weld/Trial Weld

   Pre-welds or trial welds shall be taken to verify the performance of welding equipment, seaming methods, and conditions. No seaming equipment or seamer shall be allowed to perform production welds until equipment and seamers have successfully completed trial weld(s). Pre-welds should be made in the same surroundings and environmental conditions as the production welds, i.e., in contact with the geotextile. Pre-welds shall be performed at the following frequency:

   a. At all start-ups and prior to planned shutdowns.

   b. Throughout the day as equipment requires start-up after a breakdown.

   c. At a minimum of 4 hour intervals or as directed by QA Representative.

9. Samples should be at least 2 feet long and 1 foot wide with the seam centered lengthwise. (Typically the samples are made by the welder seaming two pieces of the geomembrane together). Ten, 1-inch wide strips should be cut from the trial weld.

10. Specimens should be quantitatively tested for peel adhesion and for bonded seam strength (shear) using a recently calibrated field tensiometer. A specimen is considered to pass when the following results are achieved. (For double-wedge welding, both welds shall be tested and both shall be required to pass in peel).

    a. The break is film tearing bond (FTB).

    b. The break is ductile.

    c. The test results are consistent with test requirements established in paragraph 3.4(B) of Specification Section 02755.

11. Repeat the trial weld in its entirety when any of the trial weld samples fail in either peel and shear. When repeating trial welds fail, seaming apparatus and seamer shall not be used for production welding until deficiencies or conditions are corrected and two consecutive successful trial welds are achieved.

12. All trial welds shall be recorded by the Contractor on Form 3 (Pre-Weld and Geomembrane Seaming Record).

    a. Equipment - Extrusion fillet welders, extrusion flat wedge welders and hot wedge welders are the pieces of equipment approved for field seaming.

13. Non-Destructive Seam Testing

    Purpose of non-destructive testing is to check the continuity of the seam. The Contractor shall non-destructively test all field seams over their full length. All test equipment shall be furnished by the Contractor. Results of non-destructive testing shall be recorded on Form 4 non-destructive air pressure testing summary.

14. Destructive Seam Testing

    The purpose of destructive testing is to determine and evaluate seam integrity and assess long-term performance.

The Contractor shall provide a minimum of one destructive test sample per 500 feet of seam length from a location specified by QA Representative; individual samples may be taken at greater or lesser intervals.

Additional destructive tests may be taken in areas of contamination, offset welds, visible crystallinity or other potential cause of faulty welds, as determined by QA Representative.

All destructive seam samples shall be recorded by the Contractor on the Destructive Sample Record (Form 5). Information to be recorded includes date, sample number, seam number, machine number, seamer, date sent to lab and a summary of any field test performed.

a. Shear testing will be performed in accordance with ASTM D4437-NSF modified. This test involves peeling the sheets apart to observe how separation occurs. Results indicate whether or not the sheets are continuously and homogeneously connected through the seam.

b. Ten 1-inch wide replicate specimens shall be cut from the sample. Five specimens shall be tested for shear strength and five for peel adhesion. The test seam area will be considered acceptable if four of the five samples for each test fail outside of the seam area, provided all five samples must meet the following strength requirements:

SEAM PROPERTIES

TEST	TEST METHOD	FAILURE CRITERIA
Bonded Shear Strength (lb/in), min.	ASTM D 4437 - NSF Modified	100 (and Film Tear Bond) and >100% elongation
Seam Peel Adhesion (lb/in), min.	ASTM D 4437 - NSF Modified	90 (Fusion) and 75 (Fillet) Film Tear Bond and <30% Separation

Contractor shall document all actions taken in conjunction with destructive test failures.

15. Defects and Repairs

a. Identification - All seams and the entire geomembrane surface shall be inspected by the Contractor for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Unacceptable panels shall be removed and replaced. Because light reflected by the geomembrane helps detect defects, the surface of the geomembrane shall be clean at the time of observation. Reflecting light will cause the surface of the geomembrane, at locations where there are imperfections, to appear white or light in color. The geomembrane surface shall be brushed, blown, or washed by the Installer if the amount of dust or mud inhibits observation, as determined by QA Representative.

b. Evaluation - Any suspect locations shall be non-destructively tested as appropriate in the presence of QA Representative. Each location that fails the non-destructive testing shall be marked by the Contractor, and repaired accordingly.

c. Repair Procedures - Any portion of the geomembrane exhibiting a flaw or failing a destructive or non-destructive test shall be repaired.

1. Defective seams shall be restarted/reseamed as described in these specifications.

2. Small holes shall be repaired by extrusion welding. If the hole is larger than 1/4-inch, it shall be patched.

3. Long lengths of failed seams shall be cap stripped.

4. Tears shall be repaired by patching. Where the tear is on a slope or an area of stress and has a sharp end it must be rounded by cutting prior to patching.

5. Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by large patches.

6. Surfaces of the geomembrane which are to be patched shall be abraded, cleaned and extrusion welded.

7. Folds shall be removed or patched.

Patches shall be round or oval in shape, made of the same geomembrane, and extended a minimum of 6 inches beyond the edge of defects. All patches shall be the same compound and thickness as the geomembrane specified. All patches shall have their top edge beveled with a grinder prior to placement on the geomembrane. Patches shall be applied using approved methods only.

All surfaces must be clean and dry at the time of repairs. All seaming equipment used in repairs must be approved by QA Representative and Contractor. All repair procedures, materials, and techniques shall be approved in advance of the specific repairs by QA Representative and Contractor.

Form 6 (FML Repair Locations) shall be completed by the Contractor to document repairs.

a. Restart/Reseaming Procedures - The welding process shall restart by grinding the existing seam and rewelding a new seam. Welding shall commence where the grinding started and must overlap the previous seam by at least two inches. Reseaming over an existing seam without regrinding shall not be permitted. Reseaming must be approved by QA Representative.

b. Verification of Repairs - Each repair shall be non-destructively tested. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved. QA Representative shall take additional destructive seam samples, as necessary, for long lengths of cap stripped seam.

c. Recording of results: daily documentation of all non-destructive and destructive tests shall be prepared by QA Representative. This documentation shall identify all seams that initially fail destructive testing and indicate evidence that these seams were repaired and successfully retested. Documentation shall identify all patch, bead or cap strip locations and indicate that repairs were made and successfully tested.

PART 4: MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Measurement for payment of the geomembrane will be based on the actual number of square yards of covered surface area in-place.

4.2 PAYMENT

All prices shall include, but will not be limited to, submittals, testing, material manufacture, packaging, delivery, and storage; deployment, patches, seams, overlaps, repairs; and cleanup.

All work associated with furnishing and hauling material will not be paid separately but shall be included in the work required, or as approved by the Resident Engineer. No additional payment will be made for removing approved materials which are rendered unsuitable after placement or replacement or for removal, hauling, disposal and replacement of objectionable materials.

The completed work as measured for the cap barrier layer shall be paid for according to the unit price schedule.

PAY ITEM	UNIT
Geomembrane	Square Yard

FORM 1

MATERIAL

DELIVERY REPORT

PROJECT NAME:
PROJECT NUMBER:
LOCATION:
DATE:
MATERIAL TYPE:

ROLL NO.	BATCH NO.	RESIN TYPE	DESCRIPTION OF DAMAGE

COMMENTS:

OFF-LOADING PROCEDURES:

MATERIAL STORAGE:

FORM 2
GEOMEMBRANE PANEL DEPLOYMENT LOG

PROJECT NAME:____________________ DATE DEPLOYED:
PROJECT NUMBER:__________________ TEMP: Max:________F; Min:________F
LOCATION:_______________________ WIND:_______________ mph N S E W

ALL MEASURED IN MILS

SEAM NO.:

SEAM NO.:

SUB-GRADE ACCEPTED FOR AREA BENEATH PANEL NUMBER:
__________ Yes __________ No

REMEDIAL WORK REQUIRED:
__________ Yes __________ No

	TYPE OF WORK REQUIRED:	

REMEDIAL WORK COMPLETED AND AREA ACCEPTED:
__________ Yes __________ No

COMMENTS:	

PANEL NUMBER:________________
PANEL LENGTH:________________
ROLL NUMBER:________________

FORM 3

PRE-WELD AND GEOMEMBRANE SEAMING RECORD

PROJECT NAME:
PROJECT NUMBER:
LOCATION:
DATE:
CQA MONITOR:

WELDING MACHINE NUMBER:__________ WELDER'S NAME:

Pre-weld Seam #	Time am/pm	Temp.	Temperature of		Results		Pass/ Fail*
			Welder	Extrudate	Peel	Shear	

COMMENTS:

NOTE: USE ONLY ONE FORM PER WELDER.

* PASS OR FAIL RESULTS ARE FOR PRE-WELDS ONLY, TEST RESULTS FOR SEAMS ARE DOCUMENTED ON FORMS 4 AND 5.

FORM 4

NON-DESTRUCTIVE AIR PRESSURE SEAM TESTING

PROJECT NAME:
PROJECT NUMBER:
LOCATION:

SEAM NUMBER	CQA	TIME	PSI	DATE	TIME	PSI	PASS/ FAIL *

* REPAIRS OF FAILED SEAMS ARE DOCUMENTED ON FORM 5

** EXTRUSION WELDED

FORM 5

DESTRUCTIVE SAMPLE RECORD

PROJECT NAME:
PROJECT NUMBER:
LOCATION:

DATE	DS NO.	SEAM NO.	MACH NO.	OPER NAME	FIELD TEST		DATE TO LAB PKG SLIP NO. FEDEX/UPS
					PEEL	SHEAR	

FORM 6
FML REPAIR FORM

REPAIR DESIGNATION	DATE DAMAGE OBSERVED	DATE REPAIR CONDUCTED	SIZE	LOCATION OF REPAIR	REPAIRED TEST DATE	RESULT

END OF SECTION

ATTACHMENT D

Construction Quality Assurance Plan Replacement Pages

CONSTRUCTION QUALITY ASSURANCE PLAN
CORRECTIVE MEASURES IMPLEMENTATION
REFINED METALS CORPORATION
BEECH GROVE, INDIANA

Prepared For:

Refined Metals Corporation
Beech Grove, Indiana

Prepared By:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-18
October 6, 2010
Revised March 21, 2011

Final CM Design
Refined Metals Corporation
Beech Grove, Indiana
March 21, 2011

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LIST OF APPENDICES

1.0 OBJECTIVE

Quality Assurance is defined as a planned and systematic pattern of means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service. Quality Control is defined as those actions which provide a means to measure and regulate the characteristics of an item or service in accordance with contractual and regulatory requirements.

This Construction Quality Assurance Plan (CQAP) establishes the quality assurances procedures for implementation of the Corrective Measures (CM) Design at the former Refined Metals Corporation (RMC) facility in Beech Grove Indiana. The purpose of the CQAP is to ensure that the quality control objectives spelled out in the specifications are being met and that RMC receives a quality project that will serve its intended purpose with minimal maintenance. The activities involving quality assurance activities identified in this CQAP include the following:

- Erosion and sediment control
- Transportation of waste materials
- Dust control
- Demolition of remnant structures
- Surveying
- Soil and sediment remediation
- Earthwork
- Containment cell capping
- Restoration

2.0 RESPONSIBILITIES

Owner: Refined Metals Corporation Beech Grove (RMC).

Engineer: Advanced GeoServices Corp

Contractor: The party responsible for overall implementation of the CM Design including, but not limited to, site preparation, remediation, demolition, material handling and management, earthwork, earthwork, dust control and air sampling, water management, containment cell construction and capping, and site restoration. While portions of the work associated with implementation of the CM Design may be subcontracted by the Contractor, the Contractor is ultimately responsible for overall quality of the completed project and completion within the agreed upon schedule and budgetary amounts.

Manufacturer: The party responsible for the production and/or supplying of products and materials purchased from off-site vendors. This shall include, but not be limited to, everything from temporary controls, such as silt fence, to imported soil, aggregate and topsoil, to geosynthetic components within the containment cell cap. The Contractor is ultimately responsible for ensuring that the materials and products utilized for the project meet the requirements of the specifications and are installed in accordance with the requirements and intent of the CM Design, including this CQAP. If the Contractor wishes to propose an alternate product or material in lieu of a specified material or because the material is no longer available or inappropriate for actual field conditions, the Contractor shall notify the QA Representative and seek approval prior to delivery of such materials or products to the site.

Installer: The party responsible for field handling, transportation, storing, deploying, seaming, temporary restraining (against wind), and installation of the geosynthetic components of the containment cell cap. (In some cases, the Manufacturer and Installer or Contractor and Installer could be the same party). The Installer shall be retained by the Contractor as a subcontractor.

Quality Assurance (QA) Representative: The party retained by RMC and independent from the Contractor or any of the Contractor's subcontractors that is responsible for observing and documenting activities related to the quality assurance of the work and compliance with the requirements of the CM Design. The QA Representative will be on-site on a full-time basis and will maintain open lines of communication between the Contractor, RMC, the CM Design Engineer, regulatory representatives.

Quality Assurance Analytical Testing Laboratory: The party retained by QA Representative for the purpose of analyzing confirmatory samples and supplemental sampling of borrow source materials, crushed concrete or other analysis as deemed appropriate during the work.

Contractor's Analytical Testing Laboratory: The party retained by Contractor for the purpose of analyzing borrows source materials, air samples, crushed concrete or other analysis as deemed appropriate during the work. The QA Analytical Testing Laboratory and the Contractor's Analytical Testing Laboratory shall not be the same lab.

Geosynthetic Testing Laboratory: The party, independent from the Contractor, Manufacturer, and Installer, responsible for conducting tests on samples of the geomembrane field seams obtained at the site. Laboratory to be retained by Contractor or Installer and approved by RMC.

3.0 QUALIFICATIONS

General

Presented in this section are the minimum qualification requirements for the key organizations involved with the implementation of the CM Design. The minimum standards must be demonstrated for each of the major categories listed. Where the specific services will be performed by a subcontractor, the primary contractor must provide documentation of appropriate experience for all subcontractors proposed for the project. All personnel performing intrusive activities or working in areas of exposed contaminants shall have a minimum of 40-hours of safety training with a current 8-hour annual refresher in accordance with 29 CFR 1910.120.

QA Representative

The QA Representative shall be experienced in construction and remediation projects, shall possess strong written and verbal skills and have experience in material placement and compaction, earthwork activities, geosynthetic installation, environmental sampling and understand basic surveying techniques.

Contractor

The Contractor shall have experience in constructing projects of similar size and scope and shall have completed at least six projects involving the remediation of soil and sediment impacted by inorganic contaminants. All employees of the Contractor shall have a minimum of 40- hours of safety training with current 8-hour annual refresher in accordance with 29 CFR 1910.120, and required site training.

Installer

The Installer shall be licensed or approved to install the Manufacturer's geomembrane. The Installation Supervisor shall have installed or supervised the installation of a minimum of 5,000,000 square feet of High Density Polyethylene (HDPE) liner. The Master Seamer shall have installed a minimum of 5,000,000 square feet of HDPE experience. All other seamers shall have installed a minimum of 500,000 square feet of geomembrane. All employees of the Installer shall have a minimum of 40-hours of safety training with current 8-hour annual refresher in accordance with 29 CFR 1910.120.

4.0 INSPECTION ACTIVITIES

Erosion and Sediment Control

Prior to construction, the Contractor is required to submit manufacturer's information for silt fence, construction entrances, contaminant reduction zones and related erosion and sediment control materials as described in Specification Section 02115. The QA representative shall review the Contractor's submittals for compliance with the requirements of the Specifications and CM design.

The erosion and sediment controls provide protection against the transport of potentially contaminated sediment from the active remediation area and protection against the transport sediment from those areas not designated for remediation and those areas where remediation has been completed. During execution, the QA Representative shall ensure that erosion and sediment controls are installed as required to prevent the migration of sediment laden water (contaminated or uncontaminated) and that water from areas designated for remediation do not cross-contaminate clean areas. The review will evaluate actual site conditions against the requirements for erosion and sediment control measure as depicted on Sheet 4 of the design drawings and may adjust the proposed location, amount and type of control to fit actual conditions. The review will be conducted in cooperation with the Contractor and with input from the CM Engineer as appropriate.

As work progresses site conditions will likely change and the integrity of the silt fence may degrade because of siltation, damage or general disturbance. The QA Representative will evaluate the adequacy of installed erosion and sediment measures at a minimum on a daily basis, after each runoff producing precipitation event and when the active work zone progresses. The QA representative shall ensure that the Contractor removes accumulated sediment from erosion and sediment control measures protecting active remediation areas prior to approving restoration of the remediation areas.

Transportation of Waste Materials

Truck loading will be monitored to help prevent trucks from being overloaded, although ultimately it will be the drivers and Contractor's responsibility to be certain trucks are not overloaded. Prior to leaving the loading area the bed of each hauling unit will be covered with a closely woven net tarp or canvass tarp to prevent the escape of windblown soil during transportation to the disposal facility. Each truck will be decontaminated in the Contamination Reduction Zone (CRZ) as required to prevent the off-site migration of contaminated materials. The loading area will be maintained in a clean manner, spilled material will be cleaned up as necessary. The designated truck route to the selected disposal facility will be presented to each truck driver prior to leaving the site.

Each load of waste material destined for off-site disposal (demolition debris not approved for placement in the Containment Cell) will be transported under a properly executed Bill of Lading or Hazardous Waste Manifest, as appropriate and as required by Specification Section 01355. Each bill of lading or manifest will be numbered sequentially to allow the number of loads hauled from the site to be tracked.

The QA Representative will be responsible ensuring that RMC has approved the proposed disposal or recycling destination and waste profiles have been signed by RMC and approved by the destination facility. The QA representative shall record in his fieldbook when shipments are sent off-site, the classification of the waste (hazardous versus non-hazardous), and the destination facility. The QA representative shall track that proof of disposal and disposal weight for each shipment has been received from the Contractor.

Dust Control and Air Monitoring

It is the intent of RMC to have the Contractor perform proposed CM construction activities in a manner capable of achieving the National Ambient Air Quality Standards (NAAQS) for lead. Specification Section 02999 provides the dust control and air monitoring requirements. As shown, the Contractor is responsible for providing real-time and time-integrated air sampling. The QA Representative shall review Contractor submittals for proposed sampling equipment, analytical laboratory, sampling station/platform configuration, and qualification of Contractor personnel. The locations for the proposed time-integrated samplers (TSP and total lead samplers) shall be situated as shown on Sheet 4 of the design drawings and may only be changed with consensus approval of RMC, USEPA, IDEM and CM Engineer.

The Contractor will be required to provide real-time monitoring around the perimeter of the active remediation zone. The QA representative will calculate an allowable Trigger Level for the real-time active work zones utilizing the average lead concentration for the area being remediated and a target maximum lead in air concentration of 0.15 µg/m3.

An example calculation would be as follows:

Average lead concentration of soil being remediated = 2,000 mg/kg = 0.002 mg/mg
Target Maximum lead in air concentration = 0.15 µg/m3

Trigger Level = (0.15 µg/m3)/0.002 mg/mg = 75 µg/m3

The Trigger Level represents a conservative value to utilize as a real-time measure for dust control. During execution it is possible that the Contractor may not be able to meet the calculated value when working in a very high concentration area. When an exceedance occurs; the Contractor shall temporarily stop work, review site conditions with the QA Representative, identify alternate/additional measures and implement the agreed upon measures before continuing work. If the area continues to exceed the Trigger Level the determination to allow continued work will be made based by the QA Representative in consultation with RMC. Short-term periods when a Trigger Level is exceeded will not be considered a failure of the dust control standards, but regular or protracted exceedances will not be permitted.

During execution of the work, the QA representative will review periodically throughout each work day the location and level of protection being provided by the Contractor. The QA Representative will obtain information regarding the wind direction and wind speed periodically during the day and record the information in the fieldbook. In addition, the Contractor is required to submit daily records with the Daily Report. The QA representative will consider wind speed and direction when evaluating the adequacy of dust control measures. Under high wind or extreme dry conditions it may be necessary for the Contractor to suspend work.

The QA Representative shall ensure that the methods and means being utilized for dust control are adequate for the site conditions and activities. The QA Representative shall have the authority to stop the work if he/she believes that the dust control procedures being utilized are inadequate. Adequacy of dust controls will be determind based on visual observations, real-time air monitoring, and laboratory TSP and lead results for the high volume air monitors.

Demolition of Remnant Structures

The QA representative shall review the Contractor's schedule, techniques and proposed limits for the required demolition and confirm that the work is coordinated with other work activities, that the techniques are appropriate for the nature of the demolition and the limits are consistent with the CM Design.

Surveying

The QA Representative shall review the approach to surveying proposed by the Contractor's Surveyor for technical approach and consistency with the CM Design. Specific attention will be given to the proposed grid system and cross-sections and establishment of bench marks. The elevation of each grid shall be surveyed prior to excavation or demolition and the system utilized must be reproducible to allow the documentation of removal depths relative to starting elevations and the adequacy of restoration. This data will be compared with the site characterization previously performed to insure that the depth of excavation is adequate. The Contractor is permitted to monitor removal depths using his own equipment provided that the monitoring is tied to within 1.0 feet of the originally established grid and cross-sections and accurate to within 0.1 feet vertically.

Soil and Sediment Remediation

The Surveyor will stakeout the horizontal limits of the removal areas, and the QA Representative and Contractor shall review the staked limits for consistency with the design and actual field conditions. Discrepancies or concerns should be raised with the Engineer prior to the start of excavation in the subject area. The QA Representative shall review the Contractor's protocol and controls for establishing removal limits.

The QA Representative shall confirm that affected soil and sediments are placed in the Containment Cell in accordance with following performance criteria indentified in the CM Design.

The QA Representative shall confirm that:

- Property Owner approvals have been received.
- Water management features have been established prior to the start of removal.

- The limits of initial excavation have been clearly marked and the existing elevations have been documented prior to the start of work.
- Excavations are conducted using methods approved by the QA Representative which prevent transport of sediments and minimize generation of water.
- Excavation sequencing is conducted as proposed by the Contractor and approved by QA Representative and RMC.
- Excavations have extended only to the limits marked, unless analytical data collected by the QA Representative confirms that additional excavation is necessary.
- The Contractor is employing measures to prevent contamination of soils not indicated for excavation.
- The excavation depth has extended to the depths identified in the CM Design (+/- 3-inches) or as directed by the QA Representative based on the previous sampling results.
- Confirmatory sampling has been conducted by the QA Representative.
- All visible waste materials (slag and battery casings) have been removed to the satisfaction of the QA Representative.
- Measures are employed to minimize the amount of water generated during construction. Water removed from within the excavation is contained and treated.
- Excavations are conducted to obtain the performance standards identified in the CM Design.
- Excavated materials are transported directly to the containment cell for placement.
- Materials being placed in the containment cell are placed in 12 inch loose lifts and are being compacted in a manner to create a stable surface capable of supporting the final cap.
- Material is placed in the containment cell using the sequencing proposed by the Contractor and approved by the QA Representative.
- The maximum material size is 12 inches in the longest direction.

- The top 6 inches of material are remediated soils with a maximum particle size of 2-inches.
- Cleared and grubbed materials not shipped off-site or approved for use elsewhere on-site is ground (<3 inches in longest dimension) and placed in a single 4 inch thick maximum lift.

Sampling and Analysis

The QA Representative will ensure that the confirmatory sampling discussed in the CM Design and the SAP included as part of this CQAP are followed.

Earthwork

Imported topsoil and/or fill shall be tested for compliance with the specifications prior to delivery to the site. Topsoil placement shall be monitored to ensure that it has been graded to promote drainage and prevent ponding and that it has been placed to the elevations specified. Topsoil materials whether placed for turf establishment or placed to sustain sod shall be fertilized and amended as recommended based on the agronomy testing required by the Specifications.

The QA Representative shall monitor the placement and compaction of on-site fill materials to insure that it is being placed and adequately compacted to prevent future settlement and promote positive drainage. The QA representative shall receive and review copies of the geotechnical laboratory and field density testing performed by the Contractor's QC representative.

Containment Cell Capping

The QA Representative shall review and discuss the Contractors proposed approach (construction sequence and construction techniques) for capping the containment cell. To the extent possible, installation of the geomembrane shall be completed as soon as possible after the final tops of waste elevations are achieved. If the time between achieving final grades and geomembrane installation will be greater than one week, the Contractor shall be required to protect the completed surface using temporary plastic sheeting placed in such a manner to shed precipitation and prevent direct contact of precipitation with the contaminated soils.

The 18-inch thick cover soil layer shall be placed as a single lift and construction equipment (except small rubber tired ATVs utilized by the Installer during geosynthetic deployment) will not be permitted on to the areas of the completed geomembrane installation until the cover soil layer is in-place. QA Representative shall ensure that all required inspections and documentation of the liner installation activities is completed prior to soil placement.

Topsoil will be submitted to a soils laboratory for analysis to insure that the topsoil is amended with the proper amount of fertilizer and agricultural lime. Seed and fertilizer shall be selected and applied as recommended by the local USDA Soil Conservation Office. Seed variety will be selected based upon the time of year the planting is to be completed and to insure a viable stand of grass is established that will require a minimum amount of maintenance. Seed shall be state-certified seed of the latest season's crop.

5.0 SAMPLING REQUIREMENTS

The QA Representative shall report the analytical results for post-excavation sampling, with appropriate sample identification and location, to RMC and Contractor within 24 hours of receiving the results from the laboratory.

The QA Representative in consultation with RMC and the Contractor, will determine the limits and extent of further excavation based upon the results of the sample analysis. RMC and its representatives may request additional samples for analysis to assist in the determination. Excavation and confirmatory sampling will continue until the performance criteria have been met.

The QA Representative shall ensure that:

- Sampling is conducted at the frequency indicated in the Appendix A.
- Post-excavation samples within HWMUs are analyzed for total lead, arsenic, antimony, cadmium and selenium. Post-excavation samples outside of HWMUs are analyzed for total lead.
- Performance standards are as indicated in the Specifications.

6.0 DOCUMENTATION

An effective CQAP depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of Quality Assurance activities. The QA Representative will document that the Quality Assurance requirements have been addressed and satisfied.

Following review, the QA Representative will provide the RMC with signed descriptive remarks, data sheets, and logs to verify that the monitoring activities have been carried out in accordance with the CQAP and that performance standards established in the CM Design Report have been achieved. The Contractor will maintain at the Site a complete file of the CM Design Report, Drawings and Specifications, CQAP, checklists, test procedures, daily logs, and other pertinent documents.

Daily Recordkeeping

The QA Representative's standard reporting procedures will include preparation of a weekly CQA report which, at a minimum, will consist of:

- a discussion of Site activities, including CQC testing, performed during the week;
- CQA and regulatory personnel and visitors present at the Site;
- field notes, including memoranda of meetings and/or discussions with participating parties or regulatory authorities;
- CQA monitoring logs and testing data sheets;
- construction problem and solution summary sheets;
- submittal status;
- date and weather conditions; and,

- signature of the QA Representative.

This information will be regularly submitted to and reviewed by RMC.

Monitoring Logs and Test Data Sheets

CQC monitoring logs and test data sheets will be prepared daily by the Contractor. When QA testing is performed, related monitoring logs and test data sheets shall be completed by the QA Representative for that work. At a minimum, these logs and data sheets will include the following information:

- an identifying sheet number for cross referencing and document control;
- date, project name, location, and other identification;
- data on weather conditions;
- descriptions and locations of ongoing construction;
- equipment and personnel in each work area, including subcontractors;
- descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;
- locations where tests and samples were taken;
- a summary of test results;
- calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;
- delivery schedule of off-site materials received, including Quality Control documentation;
- decisions made regarding acceptance of units of work, and/or removal activities to be taken in instances of substandard quality; and,
- signature.

RMC will be made aware of any significant recurring non-conformance with the Specifications. The Engineer will review the issues with the QA Representative to determine the cause of the non-conformance and recommend appropriate changes in procedures or Specifications. These changes will be submitted to the IDEM and the USEPA, as appropriate.

A summary of the supporting data sheets, along with final testing results and the QA Representative's approval of the work, will be required upon completion of construction.

Photographic Documentation

Photographs will be taken by the Contractor in order to serve as a pictorial record of work progress, problems, and removal activities. The basic file will contain color prints, labeled with the date, and subject of the photograph. These records will be presented to RMC upon completion of the project. Photographic reporting data sheets, where used, will be cross-referenced with observation and testing data sheet(s), and/or construction problem and solution data sheet(s). The Contractor will allow the RMC representatives to examine photographs at the Site, upon request.

Corrective Measures Design Plan and/or Specification Changes

The CMD and/or Specifications changes may be required during construction. In such cases, the Contractor will notify RMC and QA Representative when a change is believed to be warranted. Changes will be made only with the written agreement of the Engineer (following review and consultation with QA Representative, IDEM and USEPA, if necessary), and will take the form of an addendum to the Specifications.

Signatures and Final Report

At the completion of the work, the QA Representative will submit to RMC signed and sealed Final Reports. These reports will include an appropriate certification statement and will certify: (i) that the work has been performed in compliance with the CMD; (ii) physical sampling and testing, except as properly authorized, have been conducted at the appropriate frequencies; and (iii) that the summary document provides the necessary supporting information.

At a minimum, this report will include: (i) summaries of all construction activities; (ii) testing data sheets including sample location plans; (iii) construction problems and solutions data sheets; (iv) changes from design and Specifications; (v) record (as-built) drawings (to be provided by the Contractor); and (vi) a summary statement sealed and signed by a Professional Engineer registered in the State of Indiana.

The as-built drawings provided by the Contractor will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g. depths, plan dimensions, elevations, etc.). All surveying and base maps required for development of the record drawings will be prepared by the Contractor's qualified licensed land surveyor.

The documentation and information to be collected by the QA Representative from the Contractor for use in development of the Final Report shall include the following:

- Surveyor qualifications, including proof of Health and Safety training;
- Geomembrane Manufacturer qualifications;
- Geomembrane Installer qualifications;
- Other subcontractor qualifications;
- Contractor's Health and Safety Plan;

- Project record (as-built) drawings as required by Specification Section 01050;
- Restoration summary;
- Permits obtained by Contractor or Owner;
- Representative photographs;
- Validated soil sampling results including laboratory reports;
- If used, off-site disposal completed manifests, weight tickets, and certificates of disposal;
- Compaction test results;
- QC certificates for each roll of geosynthetic;
- Geomembrane panel layout plans;
- Installer's geomembrane certification;
- Destructive seam sample test results;
- Shear box test results;
- Quality Assurance monitoring logs and test data sheets;
- Material properties for:

  - Silt fence, and other erosion and sediment control devices;
  - CRZ and construction entrance aggregate and geotextile;
  - Water treatment system and procedures;
  - Cap geomembrane;
  - Geocomposite;
  - Aggregate and piping for cap anchor trench and outfalls;
  - Cover soil;
  - Topsoil and erosion control mat;
  - Seed, mulch and fertilizer;
  - Stormwater system piping, outlet structures and other features;
  - Fencing;

- Asphaltic Concrete Paving;
- Other site materials.

- Delivery tickets and/or certificates of compliance for all materials;
- Completed submittal register and approved submittals; and,
- Any other information needed for documentation of work in accordance with the Contract Documents.

Storage of Records

During performance of remediation activities, all records, including handwritten data sheet originals (especially those containing signatures), should be stored by the Contractor or his designee in a safe on-site repository. Other reports may be stored by a standard method which will allow for easy access.

APPENDIX A

CONFIRMATORY SAMPLING

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1.0 INTRODUCTION

1.1 GENERAL

As presented in Section 5.0 “Statement of Basis” of the Corrective Measures Design Report (Design Report), the proposed remedial activities within the horizontal limits of the former Hazardous Waste Management Units (HWMUs) shall be performed as Closure under the purview of the Indiana Department of Environmental Management (IDEM), while remediation on the remainder of the site and off-site are being performed as part of Corrective Measures under the purview of the United States Environmental Protection Agency (USEPA). Therefore, multiple remediation standards are being applied to the site. The soil standards, as discussed to greater detail in Section 5.0 of the Design Report are as follows.

1.2 CORRECTIVE MEASURES (ON-SITE AND OFF-SITE)

1.2.1 On-Site

Soil and sediment remediation on the former RMC property (outside the footprint of the HWMUs) and off-site are dictated specifically by lead. The standard for on-site for soil and sediment (outside the limits of the HWMUs) is 920 mg/kg, which corresponds to the Preliminary Remediation Goal (PRG) calculated through a site specific Baseline Human Health Risk Assessment (BHHRA) presented in and approved as part of the Corrective Measures Study (Advanced GeoServices August 6, 2007). The PRG represents the maximum allowable average concentration within a defined exposure area for the depth intervals considered in the BHHRA. For this project there are two exposure areas referred to as the “on-site exposure area” and the “grassy exposure area” (see Design Report, Figure 2) and the depth increments (“exposure depth”) are 0-5 feet and 0-2.5 feet respectively.

1.2.2 Off-Site

As shown on Sheets 7 and 8, the proposed off-site excavation areas coincide with drainage ditches and swales that received surface water runoff from the facility. Sampling conducted as part of the RFI identified elevated concentrations of lead in the sediment and soil within these features. The lead remediation value for sediment and soil within these generally accessible Off-Site Areas is 400 mg/kg. The proposed soil and sediment removal is limited to the bottoms of the drainage features where concentrated surface water runoff has resulted in a lead concentrations >400 mg/kg. Within the less clearly defined drainage swale along South Arlington Avenue, the proposed excavation activities will extend from the site security fence to the edge of pavement for the road.

1.3 HAZARDOUS WASTE MANAGEMENT UNIT CLOSURE

Soil remediation within the limits of the former HWMUs is dictated by lead, as well as antimony, arsenic, cadmium and selenium. The soil remediation standards are shown below. The standards come from the IDEM RISC Industrial Closure Levels, Table A (antimony, arsenic, cadmium and selenium), while the value for lead represents the IDEM RISC Industrial Closure Levels for Construction.

Hazardous Waste Management Units (HWMUs)

Parameter	Soil Standard
Antimony	37 mg/kg
Arsenic	20 mg/kg
Cadmium	77 mg/kg
Lead	970 mg/kg
Selenium	53 mg/kg

As discussed in Section 5.0 of the Design Report, the values for lead and arsenic were justified based on site specific SPLP testing which demonstrated average partitioning coefficients more than an order of magnitude greater than the values utilized to calculate the IDEM RISC default Migration to Groundwater values.

2.0 CONFIRMATORY SAMPLING REQUIREMENTS

2.1 RMC PROPERTY (EXCLUDING HWMUs)

The removal limits shown on Sheet 7 of the design drawings have been selected to remove the highest concentration soils within each exposure area as necessary to achieve an average soil lead concentration (PRG) within the BHHRA exposure depth (0 to 5 feet within the On-Site Exposure Area and 0 to 2.5 feet within the Grassy Exposure Area) equal to or less than 920 mg/kg. It is also the intention of RMC that the remaining soil lead concentration at the bottom of each removal area on the RMC property be less than 920 mg/kg as determined through post excavation sampling at the bottom of the excavation area.

No excavation sidewall sampling or sampling beyond the horizontal limits of the excavation is required. Bottom confirmatory samples will be performed by the QA Representative utilizing an XRF with a minimum 20 percent of the samples sent off-site for laboratory analysis. The number of locations screened on the bottom of the excavations will be determined by the area of each excavation and will follow IDEM standard guidance for post-excavation sampling set forth in the IDEM RISC Technical Guide. The number of bottom samples required within each excavation area is listed on the table presented on Sheet 7 of the design drawings. A 10 foot by 10 foot grid will be superimposed over each excavation area. Each grid node will be assigned a unique identification number. A random number generator will be used to select the node numbers that will be sampled for XRF analysis. If a node is located at an inaccessible location, the next randomly selected node number will be sampled.

Samples for XRF analysis will be collected utilizing decontaminated or disposable sampling equipment from a depth interval of 0-6 inches. The samples will be placed into separate clean plastic baggies and homogenized by hand (protected by a clean glove) for approximately 1 minute. After homogenization, the XRF will be utilized to analyze the sample for lead in accordance with the USEPA's SW-846, Method 6200. Five readings will be taken from each sample and recorded in the fieldbook and the results averaged to provide the uncorrected representative concentration.

A minimum of 20 percent of the soil samples will be submitted to the Quality Assurance Analytical Laboratory for total lead analysis (Method 6010B). The samples for laboratory analysis will be selected between 150 and 1,200 mg/kg total lead to determine a correction factor that is most applicable at the PRGs.

The laboratory results will be evaluated against the corresponding average XRF concentration and a correction factor (regression equation) coefficient of determination (r^2). A minimum of 10 samples will be used to determine the correction factor. The (XRF) data will be considered suitable for use if the $r^2 \geq 0.70$ ($r = 0.837$). The correction factor will be applied to those XRF sample results without a corresponding laboratory result. If the corrected average is less than 920 mg/kg then the excavation area will be deemed complete. If the corrected average is greater than 920 mg/kg then additional excavation will be performed within portions of the excavation area as designated by the QA Representative. The amount of additional removal will be determined by the QA Representative based on the observed sampling results and visual conditions within the excavation. After re-excavation the remediated portions will be resampled at locations approximating the locations of the previous samples and analyzed with the XRF following the same protocol described above. The average XRF result will be corrected using the correction factor. This process shall be repeated until acceptable results are achieved.

If distinct layers or pockets of slag or battery casing materials are observed in the bottom or sidewalls of the excavation area, the QA Representative will require selective removal of the identified material.

2.2 OFF-SITE

The removal depths shown on Sheet 8 of the design drawings have been selected to remove the soil and sediment materials which exceed 400 mg/kg. No sidewall sampling or sampling beyond the horizontal limits of the proposed excavation is required, except along the southern limit of excavations areas AMT-1, 2 and 3. Completeness of the vertical removal, and southern limit of excavation areas AMT-1, 2 and 3, will be determined using the XRF with 20% laboratory confirmation as described in Section 2.1. The number of locations screened on the bottom of the excavations will be determined by the area of each excavation and will follow IDEM standard guidance for post-excavation sampling set forth in the IDEM RISC Technical Guide. The number of bottom samples required within each excavation area is listed on table presented on Sheet 8 of the design drawings. A 10 foot by 10 foot grid will be superimposed over each excavation area. Each grid node will be assigned a unique identification number. A random number generator will be used to select the node numbers that will be sampled for XRF analysis. If a node is located at an inaccessible location, the next randomly selected node number will be sampled. Samples for XRF analysis will be collected utilizing decontaminated or disposable sampling equipment from a depth interval of 0-6 inches.

Sidewall samples shall be collected at a minimum frequency of once every 20 feet of side wall, but no less than 3 measurements will be taken in any excavation. Where sidewalls exhibit distinct horizons as determined by the QA Representative based on soil texture, color and structure, sidewall sampling shall be performed separately for each horizon. Side wall samples shall be collected across a 6-inch increment for the horizon represented by the sample.

The samples will be placed into separate clean plastic baggies and homogenized by hand (protected by a clean glove) for approximately 1 minute. After homogenization, the XRF will be utilized to analyze the sample for lead in accordance with the USEPA's SW-846, Method 6200. Five readings will be taken from each sample and recorded in the fieldbook.

Results of the XRF analysis within each excavation area will be averaged, and adjusted utilizing a correction factor as discussed in Section 2.1. The corrected average will be compared against 400 mg/kg. If the average exceeds 400 mg/kg, then additional removal will be required. The amount of additional removal will be determined by the QA Representative based on the observed sampling results. Following additional removal, the confirmatory sampling process will be repeated for those areas subject to additional removal at locations approximating the previous confirmatory sample location. In addition, if distinct layers or pockets of slag or battery casing materials are observed in the bottom or sidewalls of the excavation area, the QA Representative will require selective removal of the identified material.

2.3 HAZARDOUS WASTE MANAGEMENT UNITS

The proposed removal depths shown within the former HWMUs have been established based on the results of the soil sampling. Horizontal limits have been defined based on the regulatory limits (e.g. edge of the HWMU) and physical limits (such as building walls) of the units. Where the boundary of a proposed excavation area is not defined by a regulatory or physical limit, the area has been delineated based on professional judgment and interpretation relative to surrounding results.

The HWMUs are being clean-closed to the soil contaminant levels listed above, following the general procedures established in the IDEM RISC Program. In accordance with those requirements, confirmatory samples must be collected from the bottoms and sidewalls of the excavations.

The number of locations screened on the bottom of the excavations will be determined by the area of each excavation and will follow IDEM standard guidance for post-excavation sampling set forth in the IDEM RISC Technical Guide. The area of each excavation and number of screening locations is provided on Sheet 6 of the design drawings. A 10 foot by 10 foot grid will be superimposed over each excavation area. Each grid node will be assigned a unique identification number. A random number generator will be used to select the node numbers that will be sampled for XRF analysis. If a node is located at an inaccessible location, the next randomly selected node number will be sampled.

Sidewall screening will also be performed in all HWMU excavations according to IDEM guidance documents, by performing screening every 20 feet. However, no screening will be performed on sidewalls that terminate at the regulatory limit of the HWMUs or on HWMU sidewalls that are scheduled to be excavated deeper than the exposed sidewall in question. The numbers of sidewall screening locations for each HWMU are shown on Sheet 6.

Samples for XRF analysis will be collected utilizing decontaminated or disposable sampling equipment from a depth interval of 0-6 inches below the bottom of the excavation. The samples will be placed into separate clean plastic baggies and homogenized by hand (protected by a clean glove) for approximately 1 minute. After homogenization the XRF will be utilized to analyze the sample for lead, arsenic, antimony, cadmium and selenium, in accordance with the USEPA's SW-846, Method 6200. Five readings will be taken from each sample and recorded in the fieldbook and the results averaged to provide the uncorrected representative concentration. A minimum of 20 percent of the soil samples will be submitted to the Quality Assurance Analytical Laboratory for total lead analysis. The laboratory results will be evaluated against the corresponding average XRF concentration and a correction factor (regression equation) will be developed for each parameter as discussed in Section 2.1. The correction factor will be applied to those XRF sample results without a corresponding laboratory result. The corrected average will be compared against the soil standards listed in the CM Design Report. If the corrected average is less than the soil standards, then the excavation area will be deemed complete. If the corrected average is greater than the soil standards, then additional excavation will be performed within portions of the excavation area as designated by the QA Representative. The amount of additional removal will be determined by the QA Representative based on the observed sampling results and visual conditions within the excavation. After re-excavation the remediated portions will be resampled at locations approximating the locations of the previous samples and analyzed with the XRF following the same protocol described above. The average XRF result will be corrected using the correction factor. This process shall be repeated until acceptable results are achieved.

If distinct layers or pockets of slag or battery casing materials are observed in the bottom or sidewalls of the excavation area, the QA Representative will require selective removal of the identified material.

APPENDIX B

EARTHWORK

Final CM Design
CQAP Appendix B
Refined Metals Corporation
Beech Grove, Indiana
March 21, 2011

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1.0 INTRODUCTION

1.1 TERMS OF REFERENCE

1.1.1 Purpose

This appended section of the Construction Quality Assurance Plan (CQAP) addresses quality assurance requirements for earthwork operations during implementation of the Corrective Measures at the RMC facility Beech Grove, Indiana. The appendix details construction monitoring activities, soil sampling, soil testing and documentation.

1.1.2 References

ASTM D 421 Test Method for Dry Preparation for Soil Samples for Particle-Size Analysis and Determination of Soil Constants.

ASTM D 422 Test Method for Particle-Size Analysis of Soils

ASTM D 698 Test Method for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using a 5.5-lb (249-kg) Rammer and 12-inch (305-mm) Drop.

ASTM D 1556 Test Method for Density of Soil In Place by the Sand-Cone Method

ASTM D 1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop

ASTM D 2487 Test Method for Classification of Soils for Engineering Purposes

ASTM D 2922 Test Methods for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)

ASTM D 3017 Test Method for Water Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth)

ASTM D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.2 MEETINGS

To maintain a high degree of quality during earthwork operations, open channels of communication are required. Project Progress Meetings will be conducted as required by Specification Section 01200.

2.0 SOIL EVALUATION

The Contractor will provide as a pre-construction submittal laboratory analytical and geotechnical results for each of the proposed off-site soil and topsoil borrow sources proposed for use on this project. The soil evaluation shall be repeated each time a material variation is noted by the QA Representative in the field and for each new borrow source. The Contractor shall submit the samples to an independent laboratory for the following test:

GEOTECHNICAL PROPERTIES

Property	Test Method
Gradation	ASTM D 422
Plasticity	ASTM D 4318
Unified Soil Classification	ASTM D 2487
Modified Proctor Compaction	ASTM D 1557
Atterberg Limits	ASTM D 423 and D 424

Note: Modified Proctor Compaction Analysis is not required for propose topsoil sources.

ANALYTICAL TESTING

Analyte	Method
TAL Metals	SW-846 6010/6020
TCL VOCs	SW-846 8260B
TCL SVOCs	SW-846 8270C

Soil fill sources may not be from off-site industrial property borrow source. Quarry sources for aggregate and sand materials must be identified before the project begins and state-permitted borrow quarries are required.

Material which does not meet the project specifications and satisfaction of RMC shall not be used at the site. The QA representative, in consultation with the CM Engineer shall determine the acceptability of soil fill material with respect to the project specifications (Section 02210).

3.0 PLACEMENT AND COMPACTION

3.1 WEATHER CONDITIONS

Placement of soil fill shall be suspended if climatic conditions are inappropriate, as determined by the QA Representative. Precipitation and cold weather may prohibit fill placement. Soil fill shall not be placed when the material to be placed or the surface of the material in-place is frozen or wet.

3.2 FOUNDATION PREPARATION

Areas which are to receive soil fill shall be proofrolled prior to soil placement. Areas with free or standing water are to be considered unacceptable. Areas which exhibit excessive pumping or yielding shall be reworked and recompacted or undercut and replaced. The Contractor is responsible for the subrgade condition. The QA Representative shall determine and document the acceptability of soil fill areas.

3.3 FILL PLACEMENT

All cap soil fill shall be placed to the lines and grades shown on the project drawings. Survey controls required for earthwork placement shall be established by a professional surveyor. Controls shall be established based upon the vertical and horizontal reference system develop by the Contractor's Surveyor prior to soil remediation activities.

The QA Representative shall observe soil placement. Vegetation, organic matter, trash, debris, oversized stones or other unsuitable materials shall be removed from the fill soil. Imported soil fill with excessive quantities of deleterious material, as determined by the QA Representative, shall be removed from the site. Soil fill shall be placed in lifts with a loose lift thickness of 12 inches or less.

Successive layers of fill may not be placed until the preceding fill layer has been properly compacted, as determined by the QA Representative.

The QA Representative shall visually monitor the soil as delivered to the site. The QA Representative shall assure that the soil color, texture, consistency, gradation and plasticity are in accordance with the material accepted during the pre-construction evaluation. The QA Representative may require that the Contractor collect and re-analyze material samples to assure that the fill soil conforms with the project specifications and that the fill soil is the same material accepted by the pre-construction evaluation.

Fill soil samples shall be obtained by the Contractor at the frequency indicated below or whenever a variation in the fill material is observed. Samples shall be submitted to an independent laboratory to determine the following properties:

Property	Test Method	Frequency
Gradation	ASTM D 422	3,000 CY
Atterberg Limits	ASTM D 423 and 424	3,000 CY
Plasticity	ASTM D 4318	3,000 CY
Unified Soil Classification	ASTM D 2487	3,000 CY
Modified Proctor Compaction	ASTM D 1557	3,000 CY
Analytical Testing	(see Section 2.0)	Prior to approval and as needed (off-site)

Samples which have gradation, plasticity and material classification properties which vary significantly from those determined during the soil evaluation shall be re-tested. The QA Representative shall determine the necessity for shear strength testing. Imported material which does not meet the project specifications shall be removed from the site. The QA Representative shall determine the acceptability of soil fill material with respect to the project specifications. Any discrepancies or questions shall be clarified with the CM Engineer.

The Earthwork Contractor is responsible for maintaining and protecting fill areas from damage until final completion of the project. Travel over fill areas shall be restricted to prevent rutting or other degradation. Completed fill areas that are damaged following placement shall be scarified, filled and re-compacted to the satisfaction of the QA Representative.

3.4 COMPACTION

Compaction shall be observed by the QA Representative. The QA Representative shall observe the compaction equipment, number of passes and completeness of coverage. Soil fill shall be compacted to at least 92% of the maximum dry density as determined by the modified Proctor test, ASTM D 1557. In addition to the compaction requirement, Cap Soil Fill shall have a moisture content ranging from -5% to +3% of the optimum.

The compaction characteristics for fill soils shall be determined by an independent laboratory retained by the Contractor. A sample shall be collected by the Contractor once for every 3,000 CY or when a significant material variation is noted. The compaction characteristics shall be determined, including maximum dry density and optimum moisture content, according to ASTM D 1557. The resultant information will establish field compaction criteria.

The QA Representative shall determine the acceptability of soil compaction. Evaluation shall be based upon visual observation of material stability and in-place density testing. In-place density testing shall be performed by the Contractor's Quality Control representative by nuclear density methods, ASTM D 2922 and D 3017, at a frequency of once for every 1,000 SF placed and once per lift. If nuclear density methods are determined to be inappropriate, in-place density shall be determined according to ASTM D 1556. In-place density results must be included with daily project reports. Any soil reworking and re-compaction, as determined by the QA Representative, shall be performed by the Contractor.

3.5 ANCHOR TRENCH

The Contractor shall excavate and backfill the anchor trench for the cap systems geosynthetics and anchor trench drain according to the project specifications and quality assurance procedures outlined in the accompanying Construction Quality Assurance Plan for Geosynthetic Lining System Installation. The QA Representative shall observe anchor trench construction and backfilling.

4.0 EARTHWORK ACCEPTANCE

4.1 CONTRACTOR

The Contractor retains all ownership for the soil fill until accepted by the RMC. The Contractor remains responsible for the condition of the soil subbase until the geosynthetic lining system is installed.

4.2 RMC

RMC will accept soil fill when:

1. Soil evaluation testing is complete and the soil fill has been shown to meet project specifications.

2. Placement and compaction is completed.

3. In-place density results, daily field reports and compaction test data have been submitted.

4. As-built drawings, sealed by a registered Professional Surveyor, have been received by the Owner. As-built drawings should show elevations of the starting ground surface, bottom of excavations, restored ground surface, bottom of containment cell, top of waste in containment cell and top of cap.

APPENDIX C

GEOSYNTHETICS INSTALLATION

Final CM Design
CQAP Appendix C
Refined Metals Corporation
Beech Grove, Indiana
March 21, 2011

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LIST OF FORMS

1.0 INTRODUCTION

1.1 TERMS OF REFERENCE

1.1.1 Purpose

This manual addresses the Quality Assurance and Quality Control of the installation of high density polyethylene (HDPE) geomembrane and composite drainage net for Refined Metals Corporation Beech Grove (RMC). The manual delineates the quality procedures and standards required for production and installation.

For purposes of this document, the term "geomembrane" refers to the 60 mil textured HDPE geomembrane layer of the proposed containment cell cap as described in Section 02755 of the Specifications. The term "composite drainage layer" net shall mean the double side drainage layer as described in Section 02751 of the Specifications.

1.1.2 Quality Assurance

Quality Assurance is defined as a planned and systematic pattern of all means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service. This section also provides a methodology for resolving problems which may occur during construction.

1.1.3 Quality Control

Quality Control is defined as those actions which provide a means to measure and regulate the characteristics of an item or service in accordance with contractual and regulatory requirements.

1.1.4 References

ASTM D 570	Test Method for Water Absorption of Plastics
ASTM D 638	Test Method for Tensile Properties of Plastics
ASTM D 746	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 792	Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D 882	Test Method for Properties of Plastic Sheeting
ASTM D 1004	Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1204	Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
ASTM D 1238	Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D 1505	Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D 1603	Test Method for Carbon Black in Olefin Plastics
ASTM D 1682	Test Method for Strip Tensile Strength
ASTM D 1693	Test Method for Environmental Stress Cracking of Ethylene Plastics
ASTM D 2663	Test Method for Rubber Compounds-Dispersion of Carbon Black
ASTM D 3015	Test Method for Microscopical Examination of Pigment Dispersion in Plastic Compounds
ASTM D 4354	Standard Practice for Sampling of Geosynthetics for Testing
ASTM D 4437	Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
ASTM D 4533	Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	Test Method for Tensile Properties of Geotextiles by Wide Width Strip
ASTM D 4632	Test Method for Breaking Load and Elongation of Geotextile (Grab Method)

ASTM D 4716	Test Method for Constant Head Hydraulic Transmissivity of Geotextiles and Geotextile Related Products
ASTM D 4759	Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D 4833	Test Method for Index Puncture of Geotextiles, Geomembranes and Related Products
ASTM D 5084	Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D 5321	Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosnythetic Friction by the Direct Sheer Method.

GRI Test Method GM6 - Pressurized Air Channel Test for Dual Seamed Geomembranes
NSF Standard 54 (1991 or current) Flexible Membrane Liners

2.0 GEOSYNTHETIC MANUFACTURING AND TRANSPORTATION

2.1 GEOSYNTHETIC PROPERTIES CERTIFICATION

2.1.1 Geomembrane Raw Material

The geomembrane manufacturer is responsible for the production of geomembrane rolls from resin.

Upon delivery, the following shall be furnished by the Manufacturer:

1. Reports on tests performed by the Manufacturer to verify the quality of the resin used in the geomembrane rolls proposed for use on the project. The tests should include the following:

Required Material Properties for HDPE

TEST	METHOD	NOTES	REQUIREMENTS
SPECIFIC GRAVITY (1)	ASTM D 792 OR D 1505	1 and 2	≥0.940
CARBON BLACK CONTENT	ASTM D 1603	2	2 to 3%
MELT INDEX	ASTM D 1238 (Condition E MAX)	1 and 2	0.3 g per 10 minutes

(1) Measure prior to adding carbon black.
(2) 1 per 50,000 square feet of 1 per resin batch whichever results in a more number of tests.

2.1.2 Geomembrane

The Installer shall submit certification that all geomembrane rolls brought to the site meet the following requirements or the Manufacturers minimum published values, whichever is more restrictive. Adherence to this requirement shall be made a condition of the material purchase order.

Required Material Properties for 60 mil Textured HDPE Geomembrane

PROPERTY	TEST METHOD	TYPICAL VALUE
Thickness, mils, Minimum 1. Overall	ASTM D1593	57
Density (g/cc), minimum	ASTM D 792 or D1505	0.94
Tensile Properties	ASTM D638-NSF Modified	
1. Strength at Yield (lb/in width), minimum		126
2. Strength at Break (lb/in width), minimum		90
3. Elongation at Yield (percent), minimum		12
4. Elongation at Break (percent), minimum		100
Tear Resistance (lb) minimum	ASTM D1004	39
Low Temperature Brittleness (°C), maximum	ASTM D 746	-60
Dimensional Stability, Percent Change, Maximum	ASTM D 1204 100°C, 1 hr	+/-2.0
Environmental Stress Crack (hrs) minimum	ASTM D1693-NSF Modified	1500
Puncture Resistance, lbs., Minimum	ASTM D4833	72
Carbon Black Content (%), range	ASTM D 1603	2.0 - 3.0
Carbon Black Dispersion	ASTM D3015-NSF Modified	A1, A2

For each geosynthetic material used at the site, the Installer shall provide the following to the QA Representative:

1. A properties sheet including specified properties and testing methods.
2. A certification that property values given in the properties sheet are guaranteed by the Manufacturer.
3. Geosynthetic delivery, storage, and handling instructions.
4. One quality control certificate for every roll of geomembrane. This certificate shall include roll numbers and identification. The finished rolls shall be identified by a number corresponding to the particular batch of resin used.

The following information shall also be provided by the Installer for any extrudate used for the project.

1. Certification stating that all extrudate is from the same Manufacturer and is of the same resin type as the geomembrane seamed.
2. Copy of quality control certificates issued by the Manufacturer

2.1.3 Geotextile

The Installer shall submit certification that geotextile rolls for use in the geocomposite and anchor trench and beneath the cap geomembrane meet the following requirements or the Manufacturers minimum published values, whichever is more restrictive. Adherence to this requirement shall be made a condition of the material purchase order:

Required Material Properties of Geotextile

Properties	Test Method	Required Value – Geocomposite	Required Value – Geotextile under geomembrane
Grab Strength (lbs.), min.	ASTM D 4632	150	200
Puncture Resistance (lbs.), min.	ASTM D 4833	75	100
Tear Strength (lbs.), min.	ASTM D 4533	70	80
Mass per Unit Area (oz/sy), min.	ASTM D 3776	8	8
Apparent Opening Size (US Sieve No.)	ASTM D 4751	80	

The Installer shall provide the QA Representative with a copy of geotextile manufacturer's recommended installation procedures to be followed during geotextile installation.

2.1.4 Geonet (Geocomposite)

The Installer shall submit certification that all geonet rolls brought to the site meet the following requirements or the minimum published values, whichever is more restrictive. Adherence to this requirement shall be made a condition of the material purchase order:

Required Material Properties of HDPE Geonet

Properties	Test Method	Required Value
Transmissivity (M^2/S), min.	ASTM D 4716 i = 1.0 σ = 2,000 psf	1.4×10^{-3}
Tensile Strength (lb/in), min.	ASTM D 1682 or D 4595	22

2.1.5 Interface Friction

The Contractor shall test geosynthetic and soil layers by shear box testing (ASTM D 5321) to demonstrate the following minimum values are met:

Representative sample of site soil to Geotextile	22°
Geotextile to Textured Geomembrane	22°
Nonwoven Geotextile (Geocomposite) to Textured Geomembrane	22°
Nonwoven Geotextile (Geocomposite) to Proposed Cap Soil	22°

2.2 TRANSPORTATION AND HAULING

Geosynthetic rolls or panels shall be packaged and shipped by appropriate means so that no damage is caused. Transportation shall be the responsibility of the Installer.

2.2.1 Delivery

Off-loading and storage of the geosynthetics is the responsibility of the Installer. The Installer shall be responsible for replacing any damaged or unacceptable material at no cost to RMC. No off-loading shall be done unless the QA Representative is present. Any damage occurring during the off-loading shall be documented by the Installer and QA Representative. All damaged rolls shall be separated from undamaged rolls and stored at locations designated by the QA Representative until Installer can remove damaged materials from the site. The QA Representative will be the final authority on determination of damage. All unacceptable materials shall be removed from the site by the Installer.

The QA Representative shall visually inspect the surface of all rolls for defects and/or damage, unrolling only if necessary. Any flaws shall be immediately reported and documented.

The Installer shall take care that any equipment used in handling the geomembrane does not cause damage during the off-loading process. Appropriate handling equipment includes cloth chokers and spreader bars for loading, spreader and roll bars for deployment. Dragging panels on ground surfaces shall not be permitted. The Installer shall also assure that all personnel handle the geomembrane with care, so as not to damage the material. Geomembrane material shall not be folded; folded material shall be rejected.

Form 1 shows an example of a Material Delivery Report to be completed by the QA Representative.

2.2.2 On-Site Storage

Storage of geosynthetics shall protect them from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, or any other damage.

Storage space shall be near the site to be lined, to minimize additional handling. It shall be protected against theft, vandalism, passing vehicles, and any other hazards.

Geosynthetic rolls shall be stored on prepared surface, i.e., a smooth surface without obstructions and/or debris, (not on wooden pallets). Geosynthetic rolls may be stacked per Manufacturers recommendations but no more than three rolls high.

2.3 MATERIAL CONFORMANCE

Independent material conformance testing is not required. The Installer shall submit certifications from the geosynthetic manufacturers that the material delivered to the site meet the requirements established in this CQAP and the Specifications. Geosynthetic materials may not be used until conformance certifications are received and approved by the QA Representative. The QA Representative shall determine the acceptability of geosynthetic components. Determinations regarding the acceptability of materials not meeting the specifications can only be made by the Engineer.

3.0 GEOMEMBRANE INSTALLATION

3.1 EARTHWORK

Immediately prior to installation of the designed geosynthetic components of the cap system, the subbase surface shall be observed by the QA Representative and Installer. The decision to repair ruts or depressions, if any, shall be made by the QA Representative and Installer. The Contractor shall repair any unacceptable subbase.

All recommendations and work performed on the subbase prior to installation shall be recorded.

No liner shall be placed on surfaces not previously found acceptable to the QA Representative and Installer. If requested, the Installer must also provide USEPA and/or IDEM an opportunity to inspect the subbase prior to geosynthetic placement.

The Contractor shall be responsible for preparing and maintaining the subbase in a condition suitable for installation of the liner unless specifically agreed otherwise. Contractor responsibilities include:

1. Surfaces to be lined shall be smooth, and free of debris, roots, and angular or sharp stones larger than 2-inches. The subbase shall be compacted in accordance with the design specifications but in no event below the minimum required to provide a firm unyielding foundation sufficient to permit the movement of vehicles and welding equipment over the subbase without causing rutting. The subbase shall have no sudden or abrupt changes in grade.

2. Protection of the subbase from erosion and water ponding. Protection, if required, may consist of a thin plastic protective cover (or other material as approved by the QA Representative) installed over the completed subbase until such time as the placement of liner begins. The plastic sheeting must be removed prior to geosythetic deployment as the presence of the plastic may cause interface sliding or failure.

3. Cap anchor trench excavation and preparation.

4. All earthwork operations as detailed in the design specifications. Earthwork quality assurance shall also be performed in accordance with the Construction Quality Assurance Plan for Earthwork.

3.2 ANCHOR TRENCH

3.2.1 Excavation

The cap anchor trench shall be excavated to the line, grade, and width shown on the construction drawings, prior to cap system geosynthetic placement. The QA Representative shall verify that the anchor trench has been constructed according to the project drawings. The anchor trench shall be excavated by the Contractor. If anchor trench is excavated in a clayey soil susceptible to desiccation, no more than the amount of trench required for the lining system to be anchored in one day shall be excavated to minimize desiccation potential of the anchor trench clay soils. Rounded corners shall be provided in and at the top of the trench so as to avoid sharp bends in the geomembrane.

3.2.2 Backfilling

The anchor trench shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled by the Earthwork Contractor as outlined in the project specifications. Care should be taken when backfilling the trenches to prevent any damage to the cap geosynthetics or drainage pipe. If damage occurs, it shall be repaired by the Installer prior to the completion of the backfill.

3.3 WEATHER CONDITIONS

Welding shall not take place during any precipitation, in the presence of excessive moisture i.e., fog, dew, frost, in areas of ponded water or in presence of excessive winds, (unless wind barriers are provided).

Seaming may proceed if the geomembrane sheet temperature is above 32°F (0°C), or if it can be proven via test strips that good seams can be fabricated at lower temperatures. The QA Representative shall determine the acceptability of cold weather seaming.

Seaming may proceed if the sheet temperature is below 122°F (50°C), or if it can be proven via test strips that quality seams can be fabricated at higher temperatures. The QA Representative shall determine the acceptability of hot weather seaming. Sheet temperature should be measured by an infrared thermometer or surface contact thermocouple.

3.4 METHOD OF PLACEMENT

3.4.1 Installer Responsibility

The Installer shall be responsible for the following:

1. No equipment or tools shall damage the geosynthetic by handling, trafficking, or other means.

2. No personnel working on the lining system shall smoke, wear damaging shoes, or engage in other activities that could damage the geosynthetics.

3. The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil.

4. The method used to place geomembrane panels shall minimize wrinkles. Wrinkles shall be identified as to proper location by the Installer and shall be shown on the Installer's as-built drawings. Ballast shall be used to prevent relocation of the compensating wrinkles by wind.

5. Bridging shall be removed, unless accepted by the QA Representative.

6. Adequate loading (i.e., sandbags) shall be placed to prevent uplift by wind. (In case of high winds, continuous loading is recommended along the edges of panels to minimize risk of wind flow under the panels).

7. Direct contact with the geomembrane shall be minimized, i.e., the geomembrane in traffic areas is to be protected by geotextiles, extra geomembrane, or other materials approved by the QA Representative.

8. Panels shall not be skewed from the vertical unless presented in the panel layout plan and approved by the CM Engineer.

3.4.2 Field Panel Identification

A field panel is the unit area of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of a roll cut in the field. Each field panel shall be given an "identification code" consistent with the layout plan. This code shall be as simple and logical as possible.

3.4.3 Field Panel Placement

Field panels are installed at the locations indicated by the layout plan. Field panels may be installed in either way:

1. All field panels are placed prior to field seaming. No more panels may be placed than can be seamed by the end of the day.

2. Field panel are placed one at a time, and each panel is seamed immediately after its placement (in order to minimize the number of unseamed field panels).

Each panel placement should be recorded immediately using the daily deployment report. Identification code, location and date shall be recorded. Form 2 is used as a record of daily deployment. Form 2 shall be completed by the QA Representative. All panels that are folded shall be replaced by the Installer.

3.5 FIELD SEAMING

3.5.1 Procedures

The welding or seaming procedure consists of overlapping the two geomembrane sheets such that any liquid flowing across the seams would flow from the top panel to underlying panel.

Seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. In corners and odd shaped geometric locations, the number of field seams should be minimized.

Seams shall be aligned with the least possible number of wrinkles and "fishmouths." If a "fishmouth" or wrinkle is found, it shall be cut, removed and patched.

Personnel performing field seaming shall meet the following requirements:

1. Master Seamer Qualifications: The Master Seamer shall have completed a minimum of 500,000 square feet of geomembrane seaming work using the type of seaming apparatus proposed for use on this project.

2. Other Seamer Qualifications: Other seamers shall have seamed a minimum of 100,000 square feet of geomembrane.

3. The Master Seamer shall provide direct supervision over other seamers.

Details of each seam, including seamer, machine number, time, and temperature shall be recorded by the QA Representative on the Pre-Weld and Geomembrane Seaming Record (Form 4).

3.5.2 Pre-Weld/Trial Weld

Pre-welds or trial welds shall be taken to verify the performance of welding equipment, seaming methods, and conditions. No seaming equipment or seamer shall be allowed to perform production welds until equipment and seamers have successfully completed trial weld(s). Pre-welds should be made in the same surroundings and environmental conditions as the production welds, i.e., in contact with the subgrade. Pre-welds shall be performed at the following frequency:

1. At all start-ups and prior to planned shut-downs.
2. Throughout the day as equipment requires start-up after a breakdown.

Samples should be at least 3 feet long and 1 foot wide with the seam centered lengthwise. (Typically the samples are made by the welder seaming two piece of the geomembrane together). Ten one-inch wide strips should be cut from the trial weld.

Specimens should be quantitatively tested by the Installer for peel adhesion for bonded seam strength (shear) using a recently calibrated field tensiometer. A specimen is considered to pass when the test results are consistent with test requirements established in Section 3.7.

A trial weld sample shall be considered passing if at least eight specimens pass peel and shear tests. Five shall be tested in peel mode and five in sheer mode.

Repeat the trial weld in its entirety when any of the trial weld samples fail in either peel or shear. When repeating trial welds fail, seaming apparatus and seamer shall not be used for production welding until deficiencies or conditions are corrected and two consecutive successful trial welds are achieved.

All trial welds shall be recorded by the QA Representative on Form 3 (Pre-Weld and Geomembrane Seaming Record).

3.5.3 Equipment

Hot dual wedge welders and hand held extrusion welders are the pieces of equipment approved for field seaming. The Installer is expected to utilize the dual wedge welder to the maximum extent possible and utilize the hand held extrusion welder for patches and finishing work.

Hot Wedge Welding

Consists of placing a heated wedge, mounted on a self propelled vehicular unit, between 2 overlapping sheets which are heated above the polyethylene's melting point. After being heated by the wedge, the overlapping panels pass through a set of preset pressure wheels which compress the panels together to create a fusion weld. A dual track wedge welder will create two fusion welds separated by an unwelded channel.

The double wedge fusion welder shall be equipped with a temperature readout device which continuously monitors the temperature of the wedge.

Other equipment used during seam operations includes field tensiometer, rotary grinders, electric generators, coupon die and press and manometers/air pumps.

A recently calibrated field tensiometer shall be used for sheer and peel testing. The device shall have a load range of 0 to 500 pounds, a peak hold function and digital readout. Speed settings or 2" or 20" per minute shall be available.

Properly functioning portable electric generators must be available within close proximity of the seaming region and with adequate extension cords to complete the entire seam. These generators should be of sufficient size or numbers to handle all seaming electrical requirements. The generator must have rubber tires, be placed on a smooth plate such that it is completely stable that no damage can occur to the geomembrane or to the underlying liner or subgrade material. Fuel (gasoline or diesel) for the generator must be stored away from the geomembrane and if accidently spilled on the geomembrane must be immediately removed. The area should be inspected for damage to the geomembrane and repaired if necessary.

If applicable, manometers for testing air channel welds provided with a heavy duty needle or other approved pressure feed device, an air pump shall be provided. Two manometers shall be used in the Air-Pressure test.

A coupon die and press shall be supplied for cutting peel and shear specimens for trial seaming.

3.5.4 Seam Preparation

For wedge welding, seam preparation shall include:

1. The panels of the geomembrane shall be overlapped at least four-inches.

2. The seam area shall be cleaned prior to seaming to assure the area is clean and free of moisture, dust, dirt and debris of any kind. No grinding is required for fusion welding.

3. The panels shall be adjusted so that seams are aligned with the fewest possible number of wrinkles and "fishmouths."

4. A moveable protective layer may be used directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

3.6 NON-DESTRUCTIVE SEAM TESTING

Purpose of non-destructive testing is to check the continuity of the seam. The Installer shall non-destructively test all field seams over their full length. All test equipment shall be furnished by the Installer.

3.6.1 Vacuum Box Testing

Equipment for vacuum box testing shall consist of the following:

1. A vacuum box assembly consisting of a rigid housing, a transport viewing window, a soft neoprene or rubber gasket attached to the bottom, a valve assembly, and a vacuum gauge.

2. A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections.

3. A rubber pressure/vacuum hose with fittings and connections.

4. A plastic bucket and wide brush (or spray assembly).

5. A soapy solution.

The following procedure shall be used by the Installer:

1. Excess sheet overlap (if any) shall be trimmed away.

2. The window and gasket surfaces shall be cleaned and checked for leaks.

3. The vacuum pump shall be energized and the tank pressure shall be reduced to approximately 5 psi.

4. A strip of the geomembrane shall be wetted approximately 12 inches by 48 inches (length of the box) with a soapy solution. Size of the wet area depends on the size of the vacuum box.

3. The box shall be placed over the wetted area and compressed. Steel reinforcement that comes in contact with the liner shall not have any burs, sharp points, etc.

4. The bleed valve shall be closed and the vacuum valve shall be opened.

5. It shall be verified that a tight seal is created.

6. For a period of approximately 15 to 30 seconds, the geomembrane shall be examined through the viewing window for the presence of soap bubbles.

7. If no bubbles appear, the vacuum valve shall be closed, the bleed valve shall be opened, and the box shall be moved to the adjoining area with a minimum of 3 inches overlap. The process shall then be repeated.

8. All areas where soap bubbles appear shall be marked and repaired and then retested.

9. Vacuum box results should be recorded by the QA Representative on the Non-Destructive Seam Testing Form (Form 4). All vacuum box test shall be observed by the QA Representative.

3.6.2 Air-Pressure Testing

Air pressure testing is applicable to those processes which produce a double seam with an enclosed space. This method should be used by the Installer rather than vacuum box testing, to the maximum extent possible.

Equipment for testing air-pressure testing shall include:

1. An air pump equipped with a pressure gauge capable of generating and sustaining a pressure between 25 to 30 psi and mounted on a cushion to protect the geomembrane. The air pump may be manual or motor driven.

2. A manometer equipped with a sharp hollow needle, or other approved pressure feed device.

The following procedures shall be followed by the Installer:

1. Both ends of the seam area to be tested shall be sealed.

2. A manometer or other approved pressure gauge shall be inserted into both ends of the channel created by the double wedge or extrusion double wedge fusion welds. Means of pressurizing must be provided.

3. The air pump shall be energized to verify the unobstructed passage of air through the channel. The QA Representative shall verify unobstructed air flow.

4. The air pump shall be energized to pressure between 25 and 30 psi, the valve shall be closed, and the pressure shall be sustained for 5 minutes.

5. If there is a loss of pressure exceeding 4 psi, or the pressure does not stabilize, the faulty area shall be located, repaired, and retested.

6. The needle or other approved pressure feed device shall be removed and the hole sealed. The air channel at the other end shall be opened to insure that air pressurized the entire channel prior to removing the feed device.

7. Test results shall be recorded by the QA Repersentative on the Non-Destructive Air Pressure Seam Testing Summary (Form 4).

3.7 DESTRUCTIVE SEAM TESTING

Purpose of destructive testing is to determine and evaluate seem integrity and assess long-term performance.

3.7.1 Location and Frequency

The Installer shall provide the QA Representative with minimum of one destructive test sample per 500 feet of seam length from a location specified by the QA Representative; individual samples may be taken at greater or lesser intervals.

Additional destructive tests may be taken in areas of contamination, offset welds, visible crystallinity or other potential cause of faulty welds, as determined by the QA Representative.

The seaming technician (or Installer) shall not be informed in advance of the locations where the seam samples will be taken.

3.7.2 Sampling Procedure

In order to obtain test results prior to completion of liner installation, samples shall be cut by the Installer as seam progresses at the locations designated by the QA Representative.

The Installer shall mark all samples with the date and seam sample number. The Installer should also record, the date, location, time, and seam number for each specimen taken.

All holes in the geomembrane resulting from obtaining the seam samples shall be immediately repaired. All patches shall be vacuum tested. Sample locations should be located on the as-built drawing. All destructive seam samples shall be recorded by the QA Representative on the Destructive Sample Record (Form 5). Information to be recorded includes date, sample number, seam number, machine number, seamer, date sent to lab and a summary of any field test performed.

3.7.3 Size of Samples

The samples shall be 18 inches wide by 36 inches long with the seam centered lengthwise. This sample is usually cut in thirds, two pieces given to the QA Representative and the other given to the liner Installer. The QA Representative shall send one sample to an independent laboratory for testing. The other sample will be archived by the QA Representative in the event future testing is required.

3.7.4 Seam Testing Requirements

Destructive testing involves two techniques: Shear strength and peel adhesion. Destructive testing will be conducted by the Installer and QA Representative.

Shear testing will be performed in accordance with ASTM D 4437-NSF modified. This test involves placing a tensile stress from the top sheet through the weld and into the bottom sheet. Peel testing shall be performed in accordance with ASTM D 4437-NSF modified. This test involves peeling the sheets apart to observe how separation occurs. Results indicate whether or not the sheets are continuously and homogeneously connected through the seam.

Ten 1-inch wide replicate specimens shall be cut from the sample. Five specimens shall be tested for shear strength and five for peel adhesion. The test seam area will be considered acceptable if four of the five samples for each test fail outside of the seam area, provided all five samples must meet the following strength requirements:

SEAM PROPERTIES FOR 60 MIL TEXTURED HDPE GEOMEMBRANE

TEST	TEST METHOD	FAILURE CRITERIA
Shear Strength	ASTM D4437-NSF Modified	100 lb/in (minimum), FTB, greater than 100% elongation
Peel Adhesion	ASTM D4437-NSF Modified	75 lb/in minimum, FTB, less than 10% separation

3.7.5 Independent Laboratory Testing

The QA Representative shall package and ship to the independent laboratory, one section of every seam sample taken for third party determination of seam integrity. The samples shall be tested in accordance with the seam testing requirements. Discrepancies between project seam requirements and Manufacturer's requirements will be handled by adopting the most stringent requirement.

3.7.6 Procedures for Destructive Test Failure

One of the following procedures shall apply whenever a sample fails a field destructive test:

1. The Installer shall cap strip the seam between the failed location and any passed test location.

2. At the QA Representative discretion, the Installer can retrace the welding path to an intermediate location (at a minimum of 10 feet from the location of the failed

test), and take a sample for an additional destructive seam test. If this test passes, then the seam shall be cap stripped between that location and the original failed location. If the test fails, the process is repeated.

3. Over the length of seam failure, the contractor shall either cut out the old seam, reposition the panel and reseam, if possible, or add cap strip, as required by the QA Representative.

The QA Representative shall document all actions taken in conjunction with destructive test failures.

3.8 DEFECTS AND REPAIRS

3.8.1 Identification

All seams and the entire geomembrane surface shall be observed by the QA Representative for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Unacceptable panels shall be removed and replaced. Because light reflected by the geomembrane helps detect defects, the surface of the geomembrane shall be clean at the time of observation. Reflecting light will cause the surface of the geomembrane, at locations where there are imperfections, to appear white or light in color. The geomembrane surface shall be brushed, blown, or washed by the Installer if the amount of dust or mud inhibits observation, as determined by the QA Representative.

3.8.2 Evaluation

Any suspect locations shall be non-destructively tested as appropriate in the presence of the QA Representative. Each location that fails the non-destructive testing shall be marked by the QA Representative, and repaired accordingly.

3.8.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw or failing a destructive or non-destructive test shall be repaired.

1. Defective seams shall be restarted/reseamed as described in these specifications.

2. Long lengths of failed seams shall be capstripped.

3. Tears shall be repaired by patching. Where the tear is on a slope or an area of stress and has a sharp end it must be rounded by cutting prior to patching.

4. Blisters, holes, undispersed raw materials, and contamination by foreign mattery shall be repaired by large patches.

5. Surfaces of the geomembranes which are to be patched shall be cleansed and lystered.

6. Folds shall be removed or patched.

Patches shall be round or oval in shape, made of the same geomembrane, and extended a minimum of 6 inches beyond the edge of defects. All patches shall be the same compound and thickness as the geomembrane specified. All patches shall have their top edge beveled with a grinder prior to placement on the geommembrane. Patches shall be applied using approved methods only.

All surfaces must be clean and dry at the time of repairs. All seaming equipment used in repairs must be approved by the QA Representative and Installer. All repair procedures, materials, and techniques shall be approved in advance of the specific repairs by the QA Representative and Installer.

Form 6 (FML Repair Locations) shall be used by the QA Representative for documenting repairs.

3.8.4 Verification of Repairs

Each repair shall be non-destructively tested. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved. The QA Representative shall take additional destructive seam samples, as necessary, for long lengths of cap stripped seam.

Recording of results: daily documentation of all non-destructive and destructive tests shall be prepared by the QA Representative. This documentation shall identify all seams that initially fail destructive testing and indicate evidence that these seams were repaired and successfully retested. Documentation shall identify all patch, bead or cap strip locations and indicate that repairs were made and successfully tested.

Repair documentation shall include:

1. Panel and seam location.

2. The type of repair, i.e., patch, bead, cap strip, etc.

3. Identification of any cap strips that are repairs for failing a destructive seam test.

4. Vacuum test results on repairs.

5. Precise location of the repair.

4.0 GEOCOMPOSITE AND GEOTEXTILE INSTALLATION

4.1 HANDLING AND PLACEMENT

The geocomposite (geotextile/geonet/geotextile), geonet and geotextile shall be handled in a manner to ensure it is not damaged. Prior to and during placement, the Installer and QA Representative shall assure that:

1. The portion of the geomembrane to be covered by the composite drainage layer, geonet or geotextile has all required documentation complete.

2. The surface of the geomembrane must not contain stones or excessive dust that could cause damage. Prior to placing the composite drainage layer, the liner shall be swept clean with a soft bristle broom.

3. In the presence of winds, all geosynthetics shall be weighted with sandbags, as necessary. The Installer shall be responsible for damage caused by wind.

4. Geosynthetics shall be cut using an approved cutter, similar to a hooked razor blade. No straight blades are permitted. Care must be taken to protect underlying geomembranes if the geonet or geotextile is being cut in place.

5. Equipment used to deploy the geosynthetics shall not damage the materials or the underlying geomembrane.

6. No personnel working on the lining system shall smoke, wear damaging shoes, or engage in other activities that could damage the geosynthetics.

4.2 INSTALLATION

The Installer and QA Representative shall assure the following during geocomposite, geonet and geotextile seaming:

1. Overlap seams a minimum of six (6") inches.

2. Ties for the geonet are placed at three (3') foot intervals along the seam length. Only nylon ties which do not damage the underlying geomembrane are used; metal ties are not permitted.

3. Tying can be achieved by plastic fasteners. Tying devices shall be white or yellow for easy identification.

4. No horizontal seams are constructed on the side slopes.

5. For the geotextile component of the geocomposite sewing of the geotextile seam may be performed.

4.3 REPAIR PROCEDURES

Patching of the geonet shall be used to repair holes, tears, and defects. Patches shall provide 6" of overlap round the repaired area and shall be held in place with nylon ties. Geonet shall be removed if areas with large defects are observed. The QA Representative shall determine the acceptability of the geonet.

5.0 GEOSYNTHETIC ACCEPTANCE

5.1 INSTALLER

Installer retains all ownership and responsibilities for the geosynthetic until acceptance by the Owner.

5.2 OWNER

The Owner will accept geosynthetic installation when:

1. All required documentation from the Manufacturer and Installer has been received and approved.

2. The installation is complete.

3. Material conformance testing and destructive seam testing is complete.

4. Verification of the adequacy of all field seam and repairs, including associated testing, is complete.

5. Written certification documents, including drawings, sealed by a registered professional Engineer, have been received by RMC.

6. The Installer shall provide a final certification stating the installation has proceeded in accordance with the Specifications.

APPENDIX D

SAMPLING AND ANALYSIS PLAN

SAMPLING AND ANALYSIS PLAN
CORRECTIVE MEASURES IMPLEMENTATION
FORMER REFINED METALS CORPORATION FACILITY
BEECH GROVE, INDIANA

Prepared for:

REFINED METALS CORPORATION
Beech Grove, Indiana

Prepared by:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

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1.0 INTRODUCTION

The Sampling and Analysis Plan (SAP) presented in this attachment provides the policies, procedures, organization, objectives, functional activities, and specific Quality Assurance/ Quality Control (QA/QC) procedures that shall be employed by Refined Metals Corporation (RMC), Advanced GeoServices Corp. (Advanced GeoServices), and the Remedial Contractor during sampling associated with the proposed Corrective Measures for the RMC, Beech Grove, Indiana site to ensure that the technical data generated during the sampling are accurate and representative. This SAP provides the Quality Assurance Project Plan components.

1.1 SAMPLING AND ANALYSIS PLAN ORGANIZATION

Section 1.0	–	Introduction
Section 2.0	–	Project Description
Section 3.0	–	Project Organization
Section 4.0	–	Quality Assurance/Quality Control Objectives
Section 5.0	–	Sampling To Be Performed
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Section 10.0	–	Data Reduction Validation and Reporting
Section 11.0	–	Internal Laboratory Quality Control Check Samples and Calculations
Section 12.0	–	Performance System Audits
Section 13.0	–	Preventative Maintenance
Section 14.0	–	Specific Routine Procedures Used to Assess Data Precision, Accuracy and Completeness

Section 15.0 – Corrective Action

2.0 PROJECT DESCRIPTION

2.1 PROJECT BACKGROUND

The Refined Metals Corporation (RMC) Beech Grove facility (Site) was the location of a secondary lead smelting and refining operation from 1968 through 1995. The general location of the site is shown on Figure 1 of the CM Design Report and a detailed plan of the Site is shown on Sheet 1 of the design drawings. During its operational life, the facility handled hazardous materials or hazardous wastes under the Resource Conservation and Recovery Act (RCRA). These primarily consisted of lead acid automotive and industrial batteries, and lead-bearing materials that were processed for lead recovery.

In accordance with the requirements of RCRA, the facility completed and submitted a RCRA Part A permit application. On November 19, 1980 the facility was granted approval to operate two hazardous waste management units under Interim Status: 1) indoor waste piles; and 2) outdoor waste piles. Facility documents also identify a surface impoundment (lagoon) as a RCRA permitted unit; however, it does not appear to have been included on the Facility Part A permit until after 1991. The Surface Impoundment was, and still is, used to collect and manage facility storm water runoff. See Sheet 1 of the design drawings for the location of the RCRA Hazardous Waste Management Units (HWMUs).

The former indoor and outdoor waste piles were removed when normal facility operations ceased. The site sat idle after December 31, 1995 except for the wastewater treatment system which remained in operation to collect and manage storm water runoff from the lagoon and other site areas. Between August 2009 through early-January 2010 all buildings and structures were decontaminated and demolished, with the exception of four pump houses and the lagoon which were decontaminated, but remain in operation for on-site storm water management. Decontamination and demolition activities were performed in accordance with the *Draft*

Decontamination and Demolition Plan (Advanced GeoServices March 4, 2009) and the *Decontamination and Demolition Implementation Plan* (Focus Contracting, June 8, 2009) both of which were submitted, reviewed and approved by the USEPA and IDEM. A summary report of the decontamination and demolition activities is being prepared on a parallel track with preparation of this CM Design submission and will be included as an attachment to the Corrective Measures Completion Report to be provided following completion of the Corrective Measures.

Throughout the decontamination and demolition process storm water continued to be collected, treated as appropriate, and discharged to the City of Indianapolis POTW. Storm water sampling performed after completion of site cleaning activities has demonstrated that storm water from the lagoon and cleaned surface areas of the site can be discharged without requiring pre-treatment. In an effort to reduce the hydraulic loading on the POTW, the City of Indianapolis has requested that RMC cease discharge of the clean storm water to the sanitary sewer following completion of decontamination and demolition activities. At this time RMC has submitted a request for a "No Exposure Certification for Exclusion from NPDES Storm Water Permitting" to allow surface discharge of the storm water currently sent to the POTW. If storm water currently sent to the POTW will be surface discharged, it will most likely be sent to the drainage ditch at the north end of the property using the existing system of pumps and internal conveyance piping. RMC is also requesting approval from the City of Indianapolis to continue storm water discharge to the POTW until appropriate approvals for surface water discharge can be secured.

Additional background information is provided in CM Design Report Section 2.0. Previous soil sampling is discussed in CM Design Report Section 4.0.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The overall responsibility for the project is assigned to Mr. Matthew Love of Exide Technologies, representative of RMC. In this capacity, Mr. Love is responsible for the overall performance of the project including ensuring that the project is conducted in accordance with the Consent Decree and the Corrective Measures (CM) Design Report. This includes confirming that the Contractor, the QA Representative, and the contracted laboratory all conduct its operations in compliance with the CM Design Report.

The remedial activities will be performed by a Contractor selected based on cost and qualifications.

Construction Quality Assurance (QA) oversight will be the responsibility of RMC. Construction Quality Assurance services are expected to be provided by Advanced GeoServices utilizing personnel experienced in construction and remediation projects.

While all personnel involved in an investigation and in the generation of data are implicitly a part of the overall project and quality assurance program, certain individuals have specifically delegated responsibilities. The Information Gathering activities will be performed by Advanced GeoServices, under the direction of RMC. The AGC personnel with quality assurance/quality control (QA/QC) responsibilities are the Project Manager, QA Official, QA Manager, QA Scientist, and the field technicians. For samples collected by AGC personnel and/or their subcontractors, the analyses of the samples will be performed by Test America in North Canton, Ohio. The laboratory retains the responsibility for analytical data quality assurance, however. Specific laboratory personnel with QA/QC responsibilities include the Laboratory QA Officer and Laboratory Sample Custodian.

When sampling activities will be conducted by the Contractor, the Contractor's personnel will be required to meet the enclosed requirements.

3.1 PROJECT MANAGER

The Project Manager is an experienced manager and technical professional who assists in the coordination of the CM, participates in major meetings and regulatory negotiations and provides upper level contact for the client. The designated Project Manager is Paul Stratman, P.E., P.G.

3.2 QA OFFICIAL

The QA Official will be experienced in construction and remediation projects. The QA Official will be responsible for verifying that the Contractor's Quality Control activities are implemented in accordance with the Final Corrective Measures Design, including the Construction Quality Assurance Plan (CQAP). The QA Official is also responsible for conducting the sampling components of the CQAP.

3.3 QA MANAGER

The QA Manager will work on all projects requiring the collection of data, and as such is not directly involved in the routine performance of the technical aspects of the investigations. The QA Manager's responsibilities include the development, evaluation, and implementation of the SAP and procedures appropriate to the investigation. Additional responsibilities include reviewing project plans and revising the plans to ensure proper QA is maintained. The QA Manager is also responsible for all data processing activities, data processing QC, and final analytical data quality review.

It is a major responsibility of the QA Manager to ensure that all personnel have a good understanding of the SAP, and understanding of their respective roles relative to one another, and an appreciation of the importance of the roles to the overall success of the program.

3.4 QA SCIENTIST

The QA Scientist has primary responsibility for analytical data validation and review. In this capacity, the QA Scientist will prepare data validation reports describing data usability and analytical QC problems encountered.

3.5 FIELD TECHNICIANS

Experienced AGC Field Technicians will conduct all sampling tasks to be conducted by AGC. Select sampling will be conducted by the Contractor. One of the Field Technicians will be designated as the Field Team Leader. Their responsibilities will include the documentation of the proper sample collection protocols, sample collection, field measurements, equipment decontamination, and logbook and CHOC documentation.

3.6 ANALYTICAL LABORATORY QA OFFICER

The QA Officer has the responsibility for maintenance of all laboratory QA activities and documentation. The laboratory's designated QA Manager has been included as part of the each laboratory's quality assurance manual (QAM). The QAM from Test America has been included as Attachment A.

3.7 ANALYTICAL LABORATORY SAMPLE CUSTODIAN

The Sample Custodian's responsibilities include ensuring proper sample entry and sample handling procedures by laboratory personnel.

4.0 QUALITY ASSURANCE/QUALITY CONTROL OBJECTIVES

Site activities performed by the project team at the Site will incorporate, but not be limited to, the QA/QC procedures established herein during the removal activities.

In combination, QA and QC represent a set of procedures designed to produce analytical data of known and acceptable quality. A useful distinction between QA and QC programs can be made as follows: the QC program ensures that all information, data, and decisions resulting from the investigation are technically sound and properly documented, while the QA program assures that the QC program achieve its goals.

Data Quality Objectives (DQOs) are quantitative and qualitative statements specifying the quality of the environmental data required to support the decision making process. Separate DQOs are designed for field sampling and laboratory analysis so that clear distinctions between any problems found in the system can be isolated with respect to cause. Conversely, the DQOs are also designed to provide an indication of the variability of the overall system. The overall QA objective is to keep the total uncertainty within an acceptable range that will not hinder the intended use of the data. To achieve this, specific data requirements such as detection limits, criteria for precision and accuracy, sample representativeness, data comparability and data completeness (PARCC) are specified below.

Project specific DQOs are provided in Table 2.

4.1 PRECISION

Precision measures the reproducibility of data or measurements under specific conditions. Precision is a quantitative measure of the variability of a group of data compared to their average value. Precision is usually stated in terms of relative percent difference (RPD) or relative standard deviation (RSD). Measurement of precision is dependent upon sampling technique and analytical method. Field duplicate and laboratory duplicate samples will be used to measure precision for project samples. Both sampling and analysis will be as consistent as possible. For a pair of measurements, the RPD will be used to evaluate precision. For a series of measurements, RSD will be used to evaluate precision. The total precision of a series of measurements can be related by the additive nature of the variances. Equations for RPD and RSD are presented in Section 14.1 of this SAP.

QC samples, including field and laboratory duplicate samples will be analyzed and used to monitor precision for this project. One field duplicate will be collected for every 20 soil samples. A matrix spike sample and laboratory duplicate sample will be collected at a frequency of one set per 20 samples per matrix. All duplicate results will be evaluated during data validation with respect to the applicable DQO criteria listed in Table 2 and the Region V Standard Operating Procedure for Validation of CLP Inorganic Data (USEPA, 1993).

Precision will be evaluated for all lead analyses performed in this program using the results of field and laboratory duplicate samples.

4.2 ACCURACY

Accuracy is defined as the degree of agreement of a measurement or average of measurements with an accepted reference value. Accuracy measures the bias in a measurement system which may result from sampling or analytical error. Sources of error that may contribute to poor accuracy are:

- laboratory error;
- sampling inconsistency;

- field and/or laboratory contamination;
- sample handling;
- matrix interference; and
- preservation.

Equipment blanks, as well as matrix spike (MS) QC samples, will be used to measure accuracy for project samples. The field component of accuracy will be negligible if the sampling, preservation, and handling techniques described in this SAP are followed. Accuracy in laboratory methods and procedures will be evaluated by use of calibration and calibration verification procedures, and instrument performance solutions, at the frequency specified in the USEPA "Test Methods for Evaluating Solid Waste Physical/Chemical Methods," November 1986, SW-846 3rd edition for lead analyses. Accuracy is calculated using the equation presented in Section 14.2 of this SAP.

Field and laboratory blanks, matrix spike samples and LCSs will be used to measure accuracy for the project samples. Blanks will be used to evaluate whether laboratory or field procedures represent a possible source of contamination. Equipment blanks will be collected one per 20 samples. Matrix spike samples and laboratory duplicates will be analyzed at a frequency of one pair per 20 samples. LCSs will be analyzed at a frequency of one per matrix per 20 samples or per laboratory preparation batch, whichever is more frequent. Accuracy will be evaluated based upon blank and spiked sample results with respect to the applicable DQO criteria listed in Table 2 and the Region V Standard Operating Procedure for Validation of CLP Inorganic Data (USEPA, 1993).

The laboratory method and calibration blanks will be required to meet specific criteria for compliance as listed in SW 846 methodology.

In the data validation, all blank samples will be evaluated. The general procedure for assessing blank samples will be as follows:

- Lead results will be reviewed for all blank samples collected outside of HWMUs.
- Antimony, arsenic, cadmium, lead and selenium results will be reviewed for all blank samples collected inside of HWMUs.
- All analytes will be reviewed for blank samples for groundwater monitoring.
- All blank samples for which lead is reported above the MDL will be identified.
- If contaminants are not detected in any of the blank samples, the data will be reported unqualified for blank contamination.
- If contaminants are found in any of the blank samples, the sample concentration(s) will be reported in the data validation narrative and assessed according to the Region V Standard Operating Procedure for Validation of CLP Inorganic Data (USEPA, 1993).

4.3 DATA REPRESENTATIVENESS

Representativeness expresses the degree to which sample data represent the characteristics of the environment from which they are collected. Samples that are considered representative are properly collected to accurately characterize the contamination at a sample location. Therefore, an adequate number of sampling locations have been chosen, and the samples will be collected in a standardized method. Representativeness will be measured by the collection of field duplicates. Comparison of the analytical results from field duplicates will provide a direct measure of individual sample representativeness.

Comparison of the analytical results from field duplicate samples will provide a direct measure of the representativeness of individual sample results. The RPDs of the field duplicate results will be compared to the project-specific DQOs as given in Table 2.

4.4 DATA COMPLETENESS

Completeness is defined as the percentage of data that is judged to be valid to achieve the objectives of the investigation compared to the total amount of data. Data gaps will be continuously addressed when/if they occur by systematic re-sampling, as needed. Deficiencies in the data may be due to sampling techniques, or poor accuracy, precision, and laboratory error. While deficiencies may affect certain aspects of the data, usable data may still be extracted from applicable samples. The level of completeness, with respect to usable data, will be measured during the data assessment process by comparing the total number of data points to the number of data points determined to be usable. A usability criteria of 90 percent has been set for this project. The equation used for completeness is presented in Section 14.3 of this SAP.

4.5 DATA COMPARABILITY

Comparability expresses the confidence with which one data set can be compared with another data set from a different phase or from a different program. Comparability involves a composite of the above parameters as well as design factors such as sampling and analytical protocols. Data comparability will be ensured by control of sample collection methodology, analytical methodology and data reporting.

4.6 SENSITIVITY

Analytical methods have been selected which can provide the DLs (sensitivity), accuracy and precision criteria defined for this project. Soil samples will be prepared according to USEPA's SW846 (USEPA, 1996) method 3050B, while all field and equipment blanks will be prepared according to SW846 3010A, both hot-acid digestion procedures. All samples will be analyzed using USEPA SW-846 Method 6010B (inductively couples plasma [ICP] spectroscopy), except for antimony, which will be analyzed using USEPA SW-846 Method 6020A.

Specific QLs are highly matrix-dependent and may not always be achievable. See Table 1 for parameters to be analyzed and the corresponding methods and DQO QLs.

4.7 PROCEDURES FOR MONITORING PARCC PARAMETERS

PARCC parameters will be monitored through the submission and analyses of various types of field and laboratory QC samples. These will include appropriate equipment blanks, laboratory method blanks, field duplicates, matrix spikes, and instrument performance solutions. See Table 2 for data quality objectives.

The frequency by which the field and laboratory QC samples will be prepared and submitted is specified in Section 6.9 of this SAP.

5.0 SAMPLING TO BE PERFORMED

This section presents the post excavation screening, stockpile sampling, confirmatory sampling, sampling during monitoring well installation, Containment Cell groundwater monitoring and MNA groundwater monitoring and analysis procedures to be performed by the QA Representative during CM implementation.

5.1 FIELD XRF SCREENING

During excavation activities within areas specifically designated for post-excavation confirmatory sampling, a portable, hand held XRF device will be utilized to aid in the vertical delineation, and in some cases horizontal delineation, of contaminated material exceeding the Post Remediation Goals (PRG) for the targeted site contaminants depending on the particular remediation area.

Confirmatory samples will be collected from 0 to 6 inch depth increment in the non-HWMU areas and from the 0-6 inch and 6 to 12 inch depth increment within the HWMUs. Samples will be placed in plastic bags, homogenized and the screened with the XRF. Five separate readings will be obtained on each sample, the results recorded and then averaged. Twenty percent of the XRF samples will be submitted for laboratory analysis and the results utilized to develop a correction factor for the other XRF results. Additional detail regarding development of the correction factor is provided in CQAP Appendix A. Laboratory analyses of Site metals shall be performed using EPA Method SW-846 6010B, except for antimony, which will be analyzed using EPA Method SW-846 6020A.

Additional detail regarding XRF screening is provided in CQAP Appendix A. Manufacturer's instructions for a typical XRF unit are provided in Attachment C of this document.

5.2 CONFIRMATORY SOIL AND SEDIMENT SAMPLING

Confirmation soil samples in both HWMU excavations and non-HWMU excavations will be consistent with the general protocol established for soil samples. Materials will be homogenized by mixing in the plastic baggies for at least one minute prior to XRF testing. Samples destined for laboratory analysis will be analyzed for lead only in non-HWMUs and Sb, As, Cd, Pb and Se in HWMUs. Areas that require additional excavation after the initial confirmation samples have been collected will be identified with the excavation depth. The results of all soil samples, including the XRF sampling results, XRF correlation samples, confirmation samples and duplicates will be entered into a computerized database.

The post-excavation confirmatory sampling program will be implemented by the QA Representative in areas to demonstrate attainment with the appropriate cleanup goals. A typical description of the XRF analysis is provided, but the actual XRF manufacturer instructions should be followed when performing the analysis.

The design and rationale for confirmatory soil and sediment sampling is provided in CQAP Appendix A. Additional detail regarding XRF sampling is provided in CQAP Appendix A.

5.3 STOCKPILE SAMPLING

During the course of the work, the Contractor will generate materials that may be clean relative to the remediation standards being applied to the project and suitable for reuse during restoration. The types of material will be primarily topsoil (stripped during construction of the containment cell and SWM basin), crushed concrete and masonry (resulting from demolition of remnant slabs, concrete pavements, structures and foundations). The work may also generate material suitable for use and structural soil fill or cap soil fill (Specification Section 02210) that the

Contractor wishes to have sampled for use as "unrestricted" material. All such materials shall be segregated based on type in stockpiles not exceeding 500 cy and characterized. Stockpile characterization shall be performed using composite samples. Stockpile sampling shall be performed as described in Section 6.2.

The design and rationale for stockpile sampling is provided in the CM Design Report.

5.4 AIR MONITORING

Air quality on-site sampling and personnel sampling will be conducted by the Contractor and monitored by the QA Representative. This SAP is not intended to cover air monitoring.

5.5 SAMPLING DURING WELL INSTALLATION

As discussed in CM Design Attachment H, MNA Work Plan, during installation of monitoring wells CC-1 through CC-6, at least two (2) soil samples will be collected for chemical analysis from each boring. The data will be used for geochemical modeling, if needed. The one sample each will be collected from the unsaturated overburden soils and from within the proposed screen horizon in each boring utilizing split spoon sampling techniques. Soil samples will be submitted for laboratory pH and eH, target analyte list (TAL) metals, arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), total organic carbon and sulfate. Samples from the same depth/intervals will also be submitted for gradation (sieve and hydrometer analysis).

5.6 CONTAINMENT CELL GROUNDWATER MONITORING

As discussed in CM Design Attachment E, Operation and Maintenance Plan, groundwater monitoring will be conducted at seven shallow groundwater monitoring wells to monitor the

Containment Cell. Wells CC-1 through CC-6 and MW-2 will be sampled at least once during CM implementation and once per quarter for seven quarters following the completion of CM implementation. Groundwater sampling will be performed semi-annually in the third and fourth years following completion of CM implementation and annually thereafter.

Groundwater samples will be analyzed for total and dissolved antimony, arsenic and lead, pH and total organic carbon. Field analysis will be conducted for pH, specific conductance, and turbidity.

Additional detail regarding Containment Cell groundwater monitoring is provided in CM Design Attachment E, Operations and Maintenance Plan. The design and rationale for Containment Cell groundwater monitoring is provided in CM Design Report Section 5.5.1 and Operations and Maintenance Plan Section 2.6 and 4.2.

5.7 MNA GROUNDWATER MONITORING

Existing wells MW-1, MW-2, MW-3, MW-8, MW-9 and MW-12 will be utilized as part of the MNA sampling network. In addition, the proposed monitoring wells CC-1 through CC-6 will serve the dual purpose of monitoring the containment cell and being part of the MNA sampling network.

The MNA groundwater monitoring wells will be sampled beginning approximately one month following installation of the proposed containment cell monitoring wells. Sampling will be performed once every calendar quarter for 12 consecutive quarters with the first evaluation regarding future frequency performed after completion of the second year of monitoring (i.e., after 8 quarters). Monitoring will end when the sampling results demonstrate that the remedial goals have been attained for four consecutive quarters. If analysis after the first 12 consecutive quarters indicates increasing concentrations, RMC will continue quarterly sampling while evaluating the observed results and developing an alternate strategy for mitigating impacts.

During the first two quarterly groundwater sampling events, samples will be analyzed for total and dissolved arsenic and lead, sulfide, sulfate, nitrate arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), and manganese speciation (MnII/MnVII) for use in geochemical modeling. Beginning after the second quarterly groundwater sampling event, groundwater analysis will be limited to total and dissolved lead and arsenic, unless additional geochemical modeling is deemed appropriate. Field parameter readings to be recorded at the time of sample collection during all groundwater sampling events shall include temperature; pH; Eh; dissolved oxygen (DO); specific conductance and turbidity.

Additional detail regarding MNA sampling is provided in CM Design Attachment H, MNA Work Plan. The design and rationale for MNA groundwater monitoring is provided in CM Design Report Section 5.5.2; Attachment E, Operations and Maintenance Plan Section 4.3; and Attachment H, MNA Work Plan.

6.0 SAMPLE COLLECTION PROCEDURES

6.1 CONFIRMATORY SAMPLE COLLECTION

Prior to sampling, loose soil or debris will be removed from the area using a stainless steel spoon or shovel or disposable scoops. Sampling implements will include stainless steel trowels or disposable plastic scoops, hand augering devices, and plastic Zip-Lock® baggies. Field personnel will don a new, clean pair of disposable gloves prior to sampling at each location. All implements, if not disposable, shall be decontaminated between the collection of each sample using the protocol described in this SAP. During the collection of each sample, the physical characteristics of the soil materials shall be recorded. Samples will be thoroughly mixed in a plastic bag for at least one minute. The plastic bag containing the homogenized sample will be labeled and entered on the Chain of Custody. Each soil sample will be of sufficient volume for subsequent analytical testing requirements as provided in Table 3.

Field personnel will record the soil's physical characteristics, a description of the sample location and depth, the time period for each sample collection, surface conditions surrounding the sample location, and all pertinent meteorological information.

6.2 STOCKPILE SAMPLING

Material stockpiles shall be characterized utilizing composite soil samples. The number of composite samples required to characterize a stockpile will be dictated by the estimated size of the pile. Each composite sample shall be comprised of 4 aliquots collected at various locations around the pile.

A detailed description of the sampling procedures is as follows:

A. Estimate the volume of the stockpile. The number of composite samples required is dictated by the estimated volume, as follows:

<250 cubic yards	-	1 Composite Sample
250 to 500 cubic yards	-	2 Composite Samples

B. Divide the stockpile into sections of equal volume based on the number of composite samples required. (i.e., piles <250 cy are treated as a single volume, a pile requiring 2 composite sample is divided in half). One composite sample will be collected from each section.

C. Provide each stockpile with a distinct identification and record the information (including type of material and source area) in the field book.

D. Evaluate the piles for consistency in the visual appearance (color, gradation, etc.) of the materials. Record any notable observations in the field book.

E. Subdivide each section into four quarters of roughly equal volume.

F. For piles that are determined to be relatively consistent (i.e. homogeneous) in visual appearance, collect 1 subsample (aliquot) from each quarter, biasing one sample towards the lower third of the pile, biasing another sample towards the upper third and collecting the remaining two samples from the middle third. In piles that are observed to be heterogeneous, utilize the quartering to dictate the distribution of subsamples around the pile but also target sampling to provide a proportional representation of the various materials in the pile. Collect all subsamples from a depth of greater than one foot below the pile surface.

G. Each aliquot in a stockpile shall have approximately equal volumes and shall be collected into a disposable aluminum tray. Remove large stones, sticks and vegetation. When sampling concrete rubble, the sampler should attempt to get a representative amount of the fines contained in the material after the crushing process and should remove those pieces larger than 1.5 inches.

H. Homogenize the sample by mixing in the aluminum tray until the composite is visually uniform using a disposable scoop and/or gloved hand.

I. Transfer an adequate volume of the composite sample to a glass or other approved sample container. The volume required for the sample is provided in Table 3. Cap and label the container, wipe residual from the outside of the container and complete require chain of custody. Collect duplicate and MS/MSD samples, as required below. Discard the remaining volume of material onto the stockpile.

J. Decontaminate reusable sample equipment following the procedures described below.

K. Place a stake marked with the stockpile identification and date sampled in the pile. Inform the Contractor when sample results are received and the final designation/disposition of the pile.

6.3 SOIL SAMPLING DURING MONITORING WELL INSTALLATION

Field personnel will don a new, clean pair of disposable gloves prior to sampling at each location. All implements, if not disposable, will be decontaminated between the collection of each sample using the protocol described in this SAP. The soil material from the desired interval will be removed from the split spoon using a disposable scoop or decontaminated trowel. The sample will be placed in a plastic bag.

During the collection of each sample, the physical characteristics of the soil materials shall be recorded. Samples will be thoroughly mixed in a plastic bag for at least one minute. The plastic bag containing the homogenized sample will be labeled and entered on the Chain of Custody. Each soil sample will be of sufficient volume for subsequent analytical testing requirements, as shown in Table 3.

Field personnel will record the soil's physical characteristics, a description of the sample location and depth, the time period for each sample collection, surface conditions surrounding the sample location, and all pertinent meteorological information.

6.4 SOIL SAMPLING DECONTAMINATION

The sampling methods prescribed herein have been developed to minimize the possibility of cross-contamination. Those sampling implements which cannot be decontaminated effectively shall be disposed of between and after sample collection. Decontamination procedures for sampling equipment will be as follows:

- Remove particulate matter and surface films with tap water, Alconox and brush as necessary;
- Deionized water rinse;
- Nitric acid rinse (0.1 N);
- Deionized water rinse;
- Air dry (if possible); and
- Cover with plastic or wrap in aluminum foil if stored overnight.

Equipment blanks will be collected for decontamination QC. A description of the types and frequency of QC samples is included in Section 6.9. Any deviations from these procedures will be documented in the field logbook.

All derived wastes from each sampling event will be returned to the ground in the direct vicinity of the sample collection point.

6.5 GROUNDWATER SAMPLING EQUIPMENT

The following equipment will be used for Containment Cell groundwater monitoring and MNA sampling:

- Low-flow bladder pump and control box;
- Flow through cell;
- Generator and/or nitrogen tank;
- Laboratory supplied containers for the collection of metals samples;
- Ice cooler for sample storage and transport;
- Ice;
- pH/temperature meter;
- Field Turbidity;
- Conductivity meter;
- Depth to water meter;
- Interface probe;
- Teflon® tubing; and,
- Disposable bailers.

6.6 GROUNDWATER SAMPLING PROCEDURES

The following sections describe groundwater sampling procedures for Containment Cell groundwater monitoring and MNA sampling. Well sampling is comprised of synoptic water level measurements, field analysis, well purge techniques, sample collection, and decontamination procedures as described in more detail below. Groundwater sampling will begin at the designated up-gradient monitoring well, then proceed to the next selected well with the lowest historical total metal concentration.

6.6.1 Synoptic Water Levels

Prior to all groundwater sampling events, depth-to-water will be measured in each well in general accordance with the American Society of Testing Materials (ASTM D 4750-97) procedures using an electronic water level indicator. The synoptic measurements will include the measurement of water levels and well depths in the monitoring wells in as short a time frame as possible to determine the piezometric surface across the Site. The field personnel will measure and record the water levels in the wells to the nearest 0.01 foot using the surveyed point at the top of the inner well casing for reference. Measurements will be repeated at each well until two consecutive readings are within 0.01 feet. Total depths will also be measured and recorded in each well after (to avoid suspension of settled solids) each sampling event to evaluate whether any silting of the well has occurred between sampling rounds. Water level measurements will be collected following IDEM Guidance Documents titled Collecting Static Water Level Measurements and Developing Ground Water Flow Maps. At the time of gauging the field technician will also make any notations regarding the condition of the wells (including unsecured, broken or missing locks).

6.6.2 Field Analyses

During Containment Cell groundwater monitoring, field measurements that will be performed during well purging will include pH, specific conductivity, and turbidity. During MNA sampling, field measurements that will be performed during well purging will include pH, eH, specific conductivity, temperature, dissolved oxygen (DO), and turbidity. Measurements will be collected by inserting the appropriate probe in a closed non-dedicated plastic container (flow-through-cell) that is rinsed with deionized water prior to purging the well. Turbidity samples will be collected from the flow through cell outflow.

Calibration of the instruments will be completed at the beginning of each sampling day, checked in the middle of the day, and as otherwise necessary based on the functioning of the meters and equipment. Each meter will be field calibrated in accordance with the manufacturer's specifications and appropriate calibration solutions. All calibrations will be recorded in the field log. Field calibration procedures at a minimum will include the following:

- Calibration of the field instruments will be performed by trained technicians prior to the mobilization of equipment to the Site. All the instruments will be calibrated as specified by the manufacturer. Standard solutions will also be checked to determine stability and operating conditions. All results of field calibrations and measurements will be maintained in bound field logbooks at least daily when the instrument is in use. The recorded calibration information will include date and time of calibration results.

- pH meters will be calibrated according to the manufacturer's instructions prior to each use and will, at a minimum, consist of two standard buffer solutions (pH 4, 7, or 10) obtained from chemical supply houses. The pH values of the buffers will be compensated for the temperature at which the pH sample is measured. Verification checks will be completed at least once per day using a standard solution. The verification check results must agree within ±0.05 pH standard units or re-calibrations will be performed.

- All temperature measurements will be measured using a field thermometer and recorded to ± 0.2°C.

- Dissolved oxygen meters will be calibrated to ambient air conditions.

- Specific conductance meters will be calibrated prior to each use using a potassium chloride solution (1,000 μmhos) prepared by a qualified laboratory or chemical supplier.

- Turbidity meters will be calibrated daily prior to use by a minimum of two standards of known turbidity as prepared by the manufacturer of the instrument. These solutions should bracket the levels found in the groundwater.

All calibration procedures performed will be documented in the field logbook and will include the date and time of calibration, name of the person performing the calibration, reference standards used and instrument readings. If equipment fails calibration or equipment malfunction is noted during calibration or use, the equipment will be tagged and removed from service.

6.6.3 Purging Procedures

Sampling procedures will include water level measurements, calculation of well volumes, purging, and sampling activities. The following step-by-step procedures are in adherence to the

EPA Region IX groundwater sampling protocols for low flow pump purging and sampling, which are based upon the method of Puls and Barcelona (EPA/540/S-9S/504). If a bladder pump cannot be inserted into a well due to bent riser piping, then a peristaltic pump will be used.

Step 1 Measure depth-to-water of every well at the Site.

Step 2 Calculate one well volume of the screened or open interval.

Step 3 Lower the low-flow pump to the mid-point of the screened interval.

Step 4 Calibrate meters.

Step 5 Begin to purge well. USEPA recommends a purge rate of 200 to 300 milliliters/minute (ml/min). The purge rate should not exceed the recharge rate (i.e., less than 0.3 feet of draw down from the static water level).

Step 6 Measure purging parameters at a minimum of one per well volume or every 3 to 5 minutes. Measurements will be collected via flow through cell for pH, temperature, specific conductivity, and DO. Turbidity will be measured at the outflow of the flow through cell every 3 to 5 minutes. All measurements will be recorded in the field logbook.

Step 7 After conductivity and temperature have stabilized to within 3% over three readings, pH readings differ <0.1 standard pH units, and turbidity measurements differ within ±10%, sampling can begin after the flow-through cell is disconnected.

Step 8 Using the well purging pump, the flow rate will be reduced to 100 ml/min and the unfiltered sample will be collected out of the discharge line. The date and time of the sample collection will be recorded in the field logbook.

Step 9 Using the well purging pump, the flow rate will remain at 100 ml/min and a disposable 0.45 micron in-line filter will be place at the discharge line. The filtered sample will be collected at the discharge end of the in-line filter. The date and time of the sample collection will be recorded in the field logbook. Filtering the samples in-line, as proposed, with disposable filters will reduce sample agitation, exposure to the atmosphere, and decontamination concerns.

Step 10 Following groundwater sample collection, measure depth-to-bottom of every well at Site.

Purge water will be collected and containerized in a drum. The pump and sampling equipment will be decontaminated before and between each well.

6.6.4 Sample Collection

Groundwater samples will be collected using the low flow pump or peristaltic pump and tubing at a rate of 100 ml/min with the flow-through cell disconnected. Groundwater will be collected directly into laboratory prepared bottles. As shown in Table 3, filtered groundwater samples will be collected in one-liter HDPE bottles that are preserved with nitric acid to a pH value of less than 2 standard units. All other samples will be collected in glass or HDPE bottles with the appropriate preservation. Immediately following sample collection and labeling of bottle, the sample will be placed in an ice cooler to maintain sample at 4° C.

6.6.5 Decontamination of Groundwater Sampling Equipment

The pump will be disassembled and components will be decontaminated in the following manner:

- Alconox and water wash;
- Potable water rinse;
- Nitric acid rinse (10% solution);
- Distilled water rinse; and,
- Air dry and store pump in plastic.

To prevent possible contamination from sampling equipment, all non-dedicated sampling devices will be decontaminated. Non-dedicated equipment is the low flow pump. Sampling equipment will be constructed of inert material (e.g., stainless, Teflon®). For non-dedicated equipment, field decontamination will be performed prior to its initial use, between sampling locations and between actual samples when more than one sample is to be collected at a given location. All non-dedicated sampling equipment will be decontaminated according to the following procedure:

1. Wash equipment thoroughly with a low phosphate detergent (Alconox) and water using a brush to remove any particulate matter or surface film.
2. Rinse equipment with distilled water.
3. Rinse with diluted nitric acid (10%N).
4. Triple rinse with distilled water.
5. Air dry equipment.
6. Wrap equipment in a clean plastic sleeve or in aluminum foil if not used immediately.

Spent nitric acid will be contained in buckets or drums. After the groundwater sampling activities are complete, the containerized decontamination water will be sampled and disposed of properly.

6.7 FIELD SAMPLING DOCUMENTATION PROCEDURES

Field sampling operations and procedures will be documented by on-site personnel in bound field logbooks. Where appropriate, field operations and procedures will be photographed. Documentation of sampling operations and procedures will include documenting:

- Procedures for preparation of reagents or supplies which become an integral part of the sample (e.g., preservatives and absorbing reagents);
- Procedures for recording the exact location and specific considerations associated with sampling acquisition;
- Specific sample preservation method;
- Calibration of field instruments;
- Submission of field-based blanks, where appropriate;
- Potential interferences present at the Site;
- Field sampling equipment and containers including specific identification numbers of equipment;
- Sampling order;
- Decontamination procedures; and
- Field personnel.

Field logbooks will be waterproof and bound. The logbook will be dedicated to the job. No pages will be removed. Corrections will be made by drawing a single line through the incorrect data and initialing and dating the correction that was made to the side of the error. An initialed diagonal line will be used to indicate the end of an entry or the end of the day's activities.

6.8 SAMPLE CONTAINERS AND PRESERVATION

Table 3 lists the appropriated sample containers, preservation methods, and holding times for sample analysis. Samples will be labeled in the field according to the procedures outlined in Section 7.0 of this Attachment.

6.9 QUALITY CONTROL SAMPLES

Field QA/QC samples will be collected to determine if contamination of samples has occurred in the field and, if possible, to quantify the extent of contamination so that data are not lost. Duplicate samples, equipment blanks and matrix spike/matrix spike duplicate (MS/MSD) samples will be collected. The duplicate QC samples will be labeled with distinct identification locations and times, and submitted to the laboratory as regular samples. The actual identification of the duplicate QC samples will be recorded in the field logbook.

A summary of the field QA/QC samples to be collected during the sampling program are presented as follows:

- Equipment blanks consisting of laboratory supplied deionized water poured over sampling equipment;
- Duplicate samples for the samples sent for laboratory analysis; and,
- Matrix spike.

6.9.1 Duplicate Samples

Duplicate samples are independent samples collected in such a manner that they are equally representative of the sampling point and parameters of interest at a given point in space and time. Field duplicate samples provide precision information of homogeneity, handling, shipping, storage, preparation and analysis. Field duplicate samples will be analyzed with the original field samples for the same parameters.

Soil sample duplicates will be collected and homogenized before being split. Groundwater samples will be obtained by alternately filling sample containers from the same sampling device for each parameter. One of every twenty samples submitted for laboratory analysis will be duplicated.

6.9.2 Equipment Blanks

The equipment (rinsate) blank is designed to address cross-contamination between sample sources in the field due to deficient field equipment decontamination procedures. This blank also addresses field preservation procedures, environmental Site interference and the integrity of the source water for field cleaning.

An equipment blank will be prepared during sampling when a particular piece of sampling equipment was employed for sample collection and subsequently decontaminated in the field for use in additional sampling. Preservatives or additives will be added to the equipment blank where appropriate for the sampling parameters.

For soil sampling, the equipment blank will be composed in the field by collecting, in the appropriate container for water, a blank water rinse from the equipment (spoon, auger, corer, etc.) after execution of the last step of the proper field decontamination protocol. One equipment blank will be collected per 20 soil samples collected outside of HWMUs and sent to the off-site lab for lead analysis. One equipment blank will be collected per 20 soil samples collected inside of HWMUs and sent to the off-site lab for antimony, arsenic, cadmium, lead and selenium analysis.

For groundwater sampling, the sampling equipment will be filled with deionized water or deionized water will be pumped through the device, and transferred to the appropriate container for water. One equipment blank will be collected per 20 groundwater samples and sent to the off-site lab. During Containment Cell groundwater monitoring, the equipment blank will be analyzed for total and dissolved antimony, arsenic, and lead, pH and total organic carbon.

During the first two MNA events, the equipment blank will be analyzed for total and dissolved arsenic and lead, sulfide, sulfate, nitrate, arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), and manganese speciation (MnII/MnVII). After the first two MNA events, the equipment blank will be analyzed for total and dissolved lead and arsenic. Equipment blanks for dissolved metals will be filtered through a 0.45 μm filter prior to preservation.

6.9.3 Matrix Spike Samples

Where required by the SAP, an Matrix Spike/Matrix Spike Duplicate (MS/MSD) will be collected and analyzed for the same parameters as the parent sample. MS and MSD samples determine accuracy by the recovery rates of the compounds added by the laboratory (the MS/MSD compounds are defined in the analytical methods). The MS samples also monitor any possible matrix effects specific to samples collected from the Site and the extraction/digestion efficiency. In addition, the analysis of MS/MSD samples check precision by comparison of the two spike recoveries.

To ensure sufficient soil sample volume, MS/MSD sample locations shall have a second soil volume collected from the same diameter and depth interval as the parent sample immediately adjacent to the parent sample location. Both soil volumes will be placed into the same baggies, composited together and analyzed with the XRF before being placed into separate baggies. Each sample will be labeled with the sample number as the parent sample, designated as an MS/MSD sample, and submitted to the laboratory for the appropriate analyses. One MS/MSD sample will be collected for every 20 investigative and duplicate soil samples collected and sent to the off-site lab for analysis.

For groundwater samples, MS/MSD samples will be collected from the same location as the field sample and in the same manner. One MS/MSD sample will be collected for every 20 groundwater samples.

6.9.4 Field Blanks

Field blanks are collected during groundwater sampling by pouring demonstrated analyte-free water provided by the laboratory from one sample container into a preserved sample container identical to those provided for sample collection. One field blank will be collected for each sampling round, and will be analyzed for the same parameters as the actual samples. Field blanks for dissolved metals will be filtered through a 0.45 μm filter prior to preservation.

7.0 SAMPLE CUSTODY

Sample identification and chain-of-custody shall be maintained for the work through the following chain-of-custody procedures and documentation:

- Sample labels, which prevent misidentification of samples;
- Custody seals to preserve the integrity of the sample from the time it is collected until it is opened in the laboratory;
- Field logbooks to record information about the site investigation and sample collection;
- Chain-of-Custody records to establish the documentation necessary to trace sample possession from the time of collection to laboratory analysis; and,
- Laboratory logbooks and analysis notebooks, which are maintained at the laboratory to record all pertinent information about the sample.

The purpose of these procedures is to ensure that the quality of the sample is maintained during its collection, transportation, storage and analysis. All sample control and chain-of-custody procedures applicable to the subcontracted laboratory will be presented in the laboratory's procedures.

7.1 CHAIN-OF-CUSTODY

A sample is in custody if it is in someone's physical possession or view, locked up or kept in a secure area that is restricted to authorized personnel.

7.1.1 Field Custody Procedures

As few persons as possible should handle samples in the field. The sample collector is personally responsible for the care and custody of samples collected until they are transferred to another person. The QA Representative will determine whether proper custody procedures were followed during field work and decide if additional samples are required.

7.1.2 Sample Labels

Identification labels are to be attached to the field sample containers. The labels shall not obscure any QA/QC lot numbers on the bottles. Sample information will be printed on the label in a legible manner using waterproof ink. The identification on the label must be sufficient to enable cross-reference with the logbook.

7.1.3 Chain-of-Custody

The chain-of-custody record must be completed by the person responsible for sample shipment to the subcontracting laboratory. All constraints on time and analytical procedures should be marked on the record. The custody record should also indicate any special preservation or filtering techniques required by the laboratory.

7.1.4 Transfer of Custody and Shipment

Chain-of-Custody records must be kept with the samples at all times. When transferring the samples, the parties relinquishing and receiving them must sign, date, and note the time on the record. Each shipment of samples to the laboratory must have its own chain-of-custody record with the contents of the shipment, method of shipment, name of courier, and other pertinent information written on the record. The original record accompanies the shipment and the copies are distributed to the Project Manager. Freight bills, Postal Service receipts and bills of lading are retained as permanent documentation.

7.1.5 Custody Seals

Custody seals are adhesive-backed seals with security slots designed to break if the seals are disturbed. Seals are placed on all shipping containers, and seals shall be signed and dated before use.

7.2 SAMPLE DESIGNATION

Samples collected from each location, shall be identified by using a standard label which is attached to the sample container. The following information shall be included on the sample label:

Site name;
Date and time of sample collections;
Designation of the sample (i.e., grab or composite);
Type of sample with brief description of sampling location (depth);
Signature of sampler;
Sample preservative used; and
General types of analyses to be conducted.

7.2.1 Proposed Sample Identification System

The following sample identification system will be utilized to identify the location, type and depth of each soil sample collected. The soil removal area identification will match the designations shown on the design drawings and the grid location will utilize an alpha-numeric designation developed by the QA Representative in consultation with the Contractor. Addition information will include depth of sample relative to pre-remediation ground surface.

Type of Sample	**ID/Depth/Date**
XRF Field Screening/Confirmation	XRF-FL4B/1.0-1.5-A5
Lab Analysis Confirmation	FL4B/1.0-1.5/A5
Duplicate	FL4B-D/1.0-1.5/A5
Stockpile Composite Sample	SP-1
Groundwater	CC-1 or MW-1

The results of all samples, including the XRF sampling results, XRF correlation samples, confirmation samples and duplicates will be entered into a computerized database. The database will be divided into sections labeled with each individual excavation identification and grid number and sub grid number.

7.3 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Regulations for packaging, marking, labeling, and shipping hazardous materials are promulgated by the USDOT in the Code of Federal Regulations, 49 CFR 171 through 177. Samples obtained from the Site are anticipated to be environmental samples which are not expected to contain high levels of hazardous substances. Therefore, the shipment of samples designated as environmental samples are not regulated by DOT.

Samples collected by the QA Representative will be relinquished, directly to the laboratory, to the laboratory courier or shipped to the laboratories using the method described below. Environmental samples shall be packed prior to shipment by air using the following procedures:

TABLE 3
SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES
RMC Beechgrove, Indiana

LOCATION	MATRIX	METHOD	PARAMETER	CONTAINER	PRESERVATIVE	HOLDING TIME	MINIMUM SAMPLE VOLUME
HWMU Areas	Soil/Sediment	SW-846 6010B[1] SW-846 6020A (antimony)	Antimony, Arsenic, Cadmium, Lead, Selenium	zip lock baggies	none	6 months	5 grams
Non-HWMU Onsite Areas	Soil/Sediment	SW-846 6010B[1]	Lead	zip lock baggies	none	6 months	5 grams
Offsite Areas	Soil/Sediment	SW-846 6010B[1]	Lead	zip lock baggies	none	6 months	5 grams
Monitoring Well Installation	Soil/Sediment	SW-846 9045	pH	2 oz WMG	none	ASAP	10 grams
		US EPA 2580D	eH	8 oz WMG	none	none	25 grams
		SW-846 6010B SW-846 6020A (Antimony)	TAL metals	4 oz WMG or zip lock baggies	none	6 months 28 days (Mercury)	5 grams
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	4 oz WMG	none	28 days	5-10 grams
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	4 oz WMG	none	24 hours	10 grams
		Walkley Black	Total Organic Carbon	4 oz WMG	none	28 days	5 grams
		SW-846 9056	Sulfate	4 oz WMG	none	28 days	50 grams
		ASTM D422-63	Gradation (Sieve and Hydrometer)	1 L WMG	none	none	125 grams
Containment Cell Monitoring	Aqueous	SW-846 6010B	Total and Dissolved Lead	500 mL HDPE	HNO_3 pH<2; cool 4°C (total) cool 4°C (dissolved)	6 months	100 mL
		SW-846 6010B	Total and Dissolved Arsenic				
		SW-846 6020A	Total and Dissolved Antimony				
		SW-846 9040	pH	250 mL HDPE	cool 4°C	ASAP	100 mL
		SW-846 9060	Total Organic Carbon	500 mL amber	H_2SO_4, cool 4°C	28 days	40 mL
MNA	Aqueous	SW-846 6010B	Total and Dissolved Lead	500 mL HDPE	HNO_3 pH<2; cool 4°C (total) cool 4°C (dissolved)	6 months	100 mL
		SW-846 6010B	Total and Dissolved Arsenic				
		SW-846 9034	Sulfide	500 mL HDPE	Zn acetate/NaOH, cool 4°C	7 days	100 mL
		SM 4500 SO3 B	Sulfite	250 mL HDPE	cool 4°C	ASAP	100 mL
		US EPA 300.0	Nitrate	250 mL HDPE	cool 4°C	48 hours	100 mL
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	1 L HDPE	HCl, cool 4°C	28 days	100 mL
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	250 mL HDPE	cool 4°C	24 hours	50 mL
		Applied Speciation propriatary method	Manganese speciation (MnII/MnVII)	40 mL amber	cool 4°C	48 hours	40 mL
Equipment Blanks	Aqueous	SW-846 6010B[1] SW-846 6020A (antimony)	Total Antimony, Arsenic, Cadmium, Lead, Selenium	500 mL HDPE	HNO_3 pH<2; cool 4°C	6 months	100 mL
		SW-846 6010B[1] SW-846 6020A (antimony)	Dissolved Arsenic, Antimony, Lead	500 mL HDPE	cool 4°C	6 months	100 mL
		SW-846 9040	pH	250 mL HDPE	cool 4°C	ASAP	100 mL
		SW-846 9060	Total Organic Carbon	500 mL amber	H_2SO_4, cool 4°C	28 days	40 mL
		SW-846 9034	Sulfide	500 mL HDPE	Zn acetate/NaOH, cool 4°C	7 days	100 mL
		SM 4500 SO3 B	Sulfite	250 mL HDPE	cool 4°C	ASAP	100 mL
		US EPA 300.0	Nitrate	250 mL HDPE	cool 4°C	48 hours	100 mL
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	1 L HDPE	HCl, cool 4°C	28 days	100 mL
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	250 mL HDPE	cool 4°C	24 hours	50 mL
		Applied Speciation propriatary method	Manganese speciation (MnII/MnVII)	40 mL amber	cool 4°C	48 hours	40 mL

[1]USEPA "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", Feb. 2007, SW-846, 6th Revision.
HDPE - high density polyethylene
WMG - wide mouth glass jar
ASAP - as soon as possible

Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape.

Allow sufficient outage (ullage) in all bottles to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).

Be sure the lids on all bottles are tight (will not leak), and baggies are sealed.

Line coolers with minimum of two large trash bags. Place samples inside of lined coolers. Put ice on top of or between the samples. Pack samples securely to eliminate breakage during shipment. Tie off trash bags to seal.

Place chain-of-custody into a plastic bag, tape the bag to the inner side of the cooler lid and then close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut. Custody seals should be affixed to the top and side of the cooler so that the cooler cannot be opened without breaking the seal.

A label containing the name and address of the shipper shall be placed on the outside of the container.

7.4 SAMPLE PRESERVATION AND HOLDING TIMES

When needed, sample containers will be obtained from the subcontracting laboratory and shall be prepared with a predetermined amount of preservative for each specified sample unless otherwise stated in the site specific field plan. A list of preservatives and holding times for each type of analysis are included Table 3 of this Attachment.

7.5 LABORATORY SAMPLE CUSTODY PROCEDURES

Once the sample arrives at the laboratory, custody of the samples will be maintained by laboratory personnel. Upon receipt of the samples, the sample receipt personnel will remove the chain-of-custody from the sealed cooler and sign and record the date and time on the chain-of-custody. The samples received will be verified to match those listed on the chain-of-custody. The laboratory will document and notify the sample generators QA Manager immediately if any inconsistencies exist in the paperwork associated with the samples. The laboratory at a minimum will document the following stages of analysis: sample receipt, sample extraction/preparation, sample analysis, data reduction, and data reporting.

Samples will be given a unique laboratory identification number and logged into the Laboratory Information Management System (LIMS). The analyst will enter the analytical data into the LIMS upon analysis completion and validation. The LIMS tracks the sample until completion of the report and invoice mailing. The data archived from the LIMS will be transferred to electronic storage format and retained for five years from the completion of sample analysis.

8.0 CALIBRATION PROCEDURES AND FREQUENCY

All instruments and equipment used during sampling and analysis will be operated, calibrated, and maintained according to the manufacturer's guidelines and recommendations. Operation, calibration and maintenance will be performed by trained personnel on a daily basis. All maintenance and calibration information will be documented and will be available upon request.

Manufacturer's instructions for the XRF unit are provided in Attachment C.

9.0 LABORATORY QUALITY ASSURANCE PROGRAM

Samples will be analyzed by Test America in North Canton. The Test America quality assurance program is provided as Attachment A. The quality assurance program documents include the following:

- Title page;
- Table of contents;
- QA policy statement;
- Laboratory organization and responsibility;
- Sampling procedures and equipment;
- Sample custody;
- Data reduction, validation, and reporting;
- Performance and systems audit;
- Preventive maintenance;
- Corrective action; and
- Resumes.

10.0 DATA REDUCTION, VALIDATION AND REPORTING

10.1 DATA REDUCTION

All analytical data will be permanent, complete and retrievable. The analyst will enter the analytical data into the LIMS upon analysis completion and laboratory validation. The laboratory will report sample results on analysis report forms and provide the information referenced in the USEPA Methods for each deliverables package. All laboratory data will undergo the data validation procedures described in the Laboratory QA Manual prior to final reporting. Data will be stored on the laboratory's network until the investigation is complete and data archived from the LIMS will be transferred to magnetic tape which will be retained by the laboratory for an additional five years.

Results will be reported in micrograms per liter (ug/l) for aqueous samples or milligrams per kilogram (mg/kg) for solid samples. Equations to calculate concentrations are found in the SW-846 Method 6010B and 6020A. All blank results and QC data will be included in the data deliverables package. Blank results will not be subtracted from the sample results. The blank results and QC data will be used in data validation to review sample results qualitatively. Data validation will be performed for samples analyzed at the off-site laboratory in general accordance with the guidelines identified in Section 10.2. Outliers and other questionable data will be addressed in the data validation report and specific QA/QC flags will be applied to questionable data. The QA/QC flags will be consistent with the USEPA data validation guidelines.

All analytical data, reports, and any other project related information produced during this project will be stored in the project file at the sample generators office maintained by the Project Manager. Project reports, tables, etc. will be stored in project specific electronic files.

10.2 DATA VALIDATION PROTOCOL

Validation of analytical data as received from the off-site laboratory will be performed by an AGC QA Scientist. All data will be validated. Validation will be performed in general accordance with the following data validation guidance documents, where applicable:

- National Functional Guidelines for Inorganic Data Review, Multi-Media, Multi-Concentration. USEPA, February 1994.

- Region V Standard Operating Procedures for Validation of CLP Inorganic Data, USEPA, September 1993.

A detailed QA review will be performed on all data by the AGC QA Scientist to verify the qualitative and quantitative reliability of the data as it is presented. This review will include a detailed review and interpretation of all data generated by the laboratory. The primary tools which will be used by the AGC QA Scientist will be guidance documents, established (contractual) criteria, and professional judgement. The items that will be examined during the detailed QA review of data will consist of: sample results; analytical holding times; sample receipt condition, preservation, and cooler temperature; chains-of-custody; initial and continuing calibrations; CDRL standards; blanks (method, preparation, initial, continuing, and equipment; ICP interference check samples; surrogates; laboratory duplicates; field duplicates; internal standards; MS/MSD recoveries; laboratory control samples; serial dilutions; blank spikes; furnace QC components (post digestion spikes; MSA; correlation coefficients); GC/ECD instrument performance checks; target compound identification; and overall system performance. A typical data validation checklist is provided in Attachment B.

Based upon the detailed review of the analytical data, a data validation report will be prepared which will state in a technical, yet "user-friendly" fashion the qualitative and quantitative reliability of the analytical data. The report will consist of an introduction section, followed by qualifying statements that should be taken into consideration for the analytical results to best be utilized. Based on the QA review, qualifier codes will be placed next to specific sample results on the sample data tables, if necessary. These qualifier codes will serve as an indication of the qualitative and quantitative reliability of the data. Common qualifier codes include:

- "U" – the analyte was not detected at or above the reporting limit;
- "J" – the analyte was positively identified and detected; however, the concentration is an estimated value because the result is less than the reporting limit or quality control criteria were not met;
- "UJ" – the analyte was not detected, the associated reporting limit is an estimated value;
- "R" – data are rejected due to significant exceedance of quality control criteria. The analyte may or may not be present. Additional sampling and analysis are required to determine;
- "D" – value was obtained from reanalysis of a diluted sample;
- "DJ" – the analyte was positively identified and detected; however, the concentration is an estimated value because quality control criteria were not met *and* the value was obtained from reanalysis of a diluted sample;
- "B" – not detected substantially above the level reported in laboratory or field blanks;
- "K" – analyte present. Reported value may be biased high. Actual value is expected lower; and,
- "L" – analyte present. Reported value may be biased low. Actual value is expected to be higher.

Once the review has been completed, the AGC QA Manager will verify the accuracy of the review and will then submit these data to the AGC Project Manager. The QA Manager or designated individual will check 100% of assigned qualifiers and other hand entered items. These approved data tables and data validation reports will be signed and dated by the AGC QA Manager.

10.3 DATA VALIDATION REPORTS

Data validation reports, along with copies of all support documentation, validated data summary tables, and analytical data packages, will be submitted periodically as data are validated. Reports will be held for the duration of the project plus 5 years, at a minimum.

10.4 DATA REPORTING

All data deliverables from each laboratory must be paginated in ascending order. The laboratory must keep a copy of the paginated package in order to be able to respond efficiently to data validation inquiries. Any errors in reporting identified during the data validation process must be corrected by the laboratory as requested. All data validation inquiries to the laboratory must be addressed by a written response from the laboratory in question. The data deliverable required for this project will include a case narrative, the sample results (Form 1s), blank data, MS/MSD percent recoveries and relative percent differences, laboratory control sample percent recoveries, and any other quality control data.

11.0 INTERNAL LABORATORY QUALITY CONTROL CHECK SAMPLES AND CALCULATIONS

All QC procedures employed by the laboratory will be, at a minimum, equivalent to those required in the specified analytical methods. Laboratory QC checks are accomplished through the analyses of laboratory blanks, calibration verifications, laboratory control standards and performance evaluation samples. When internal QC results fall outside method acceptance criteria, the data will be reported, and the analysis repeated, flagged or accepted according to the specified analytical methods. The following sections describe internal laboratory QC check samples.

11.1 LABORATORY BLANKS

Method blanks are generated within the laboratory during the processing of the actual samples. These blanks will be prepared using the same reagents and procedures and at the same time as the project samples are being analyzed. If contamination is found in the method blank, it indicates that similar contamination found in associated samples may have been introduced in the laboratory and may not have been actually present in the samples themselves. Guidelines for accepting or rejecting data based on the level of contamination found in the method blank are presented in the specified analytical method.

A minimum of one method blank per 20 samples will be analyzed or, in the event that an analytical round consists of less than 20 samples, one method blank sample will be analyzed per round.

11.2 MATRIX SPIKE/MATRIX SPIKE DUPLICATES

MS analyses are performed in association with metal analyses. MS are prepared by placing a known quantity of selected target analytes into a second aliquot of an actual field sample. The spiking occurs prior to sample preparation and analysis. The MS is then processed in a manner identical to the field sample. Recovery of each of the spiked compounds reflects the ability of the laboratory and method to accurately determine the quantity of that analyte in that particular sample.

11.3 LABORATORY CONTROL SAMPLE

The Laboratory Control Sample (LCS) is prepared by the laboratory by adding analytes of known concentrations to solution (DI water for metals analysis) for analyses. The LCS is prepared, analyzed and reported once per sample delivery group (SDG). The LCS must be prepared and analyzed concurrently with the samples in the SDG using the same instrumentation as the samples in the SDG. The LCS is designed to access (on a SDG-by-SDG basis) the capability of the laboratory to perform the analytical methods. If the analytes present in the LCS are not recovered within the criteria defined in the specified analytical methods, the samples will be reanalyzed or data will be flagged.

12.0 PERFORMANCE AND SYSTEM AUDITS

12.1 LABORATORY AUDITS

The purpose of a quality assurance audit is to provide an objective, independent assessment of a measurement effort. The quality assurance audit ensures that the laboratory's data generating, data gathering, and measurement activities produce reliable and valid results. There are two forms of quality assurance audits: performance evaluation audits and system audits.

12.1.1 Performance Evaluation Audits

The purpose of performance evaluation audits is to quantitatively measure the quality of the data. These audits provide a direct evaluation of the various measurement systems' capabilities to generate quality data.

The laboratory regularly participates in performance evaluation audits as part of their laboratory certification efforts. Performance audits are conducted by introducing control samples in addition to those routinely used.

The results of the performance audits are summarized and maintained by the Laboratory QA Supervisor and distributed to the section supervisors who must investigate and respond to any out of control results.

12.1.2 Technical System Audits

A technical systems audit is an on-site, qualitative review of the various aspects of a total sampling and/or analytical system. The purpose of the technical systems audit is to assess the overall effectiveness, through an objective evaluation, of a set of interactive systems with respect to strength, deficiencies, and potential areas of concern. Typically, the audit consists of observations and documentation of all aspects of sample analyses. External and internal audits are conducted of the laboratory throughout each year.

13.0 PREVENTATIVE MAINTENANCE

13.1 FIELD EQUIPMENT

Field measurement equipment and the XRF unit will be maintained in accordance with manufacturer's instructions. All field equipment will be checked by qualified technicians prior to use in the field. The instrument operator will be responsible for ensuring that the equipment is operating properly prior to use in the field. Any problems encountered while operating the instrument will be documented in the field logbook. If problem equipment is detected or should require service, the equipment will be returned and a qualified technician will perform the maintenance required. Use of the instrument will not be resumed until the problem is resolved. Routine maintenance of field instruments will be documented in the field logbooks.

13.2 LABORATORY EQUIPMENT

Preventative maintenance and periodic maintenance is performed as recommended by the manufacturers of the equipment in use in the laboratory. Spare parts are kept in inventory to allow for minor maintenance. Service contracts are maintained for most major instruments, balances and critical equipment. If an instrument fails, the problem will be diagnosed as quickly as possible, and either replacement parts will be ordered or a service call will be placed.

Laboratory logbooks are kept by the laboratory to track the performance maintenance history of all major pieces of equipment. The instrument maintenance logbooks are available for review upon request. Specific details of preventative maintenance programs for the laboratory will be provided in the Laboratory QA Manual.

14.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

14.1 PRECISION

The precision of laboratory test results will be expressed as RPD or RSD. RPD is derived from the absolute difference between duplicate analyses divided by the mean value of the duplicates. The percent RSD is obtained by dividing the standard deviation by X. Equations for RPD and RSD are presented below:

$$RPD = \frac{|D1 - D2|}{(D1 + D2)/2} \times 100$$

Where:

D1 and D2 = the two replicate values

$$RSD = \frac{S}{X}; \text{ and } S = [n\ (x_i - x)^2/n-1]^{1/2}$$

i-1

Where:

S	=	standard deviation
x_i	=	each observed value
x	=	the arithmetic mean of all observed values
n	=	total number of values

14.2 ACCURACY

Accuracy will be calculated on the average percent recovery of spiked samples. Reference materials are essential to the evaluation of accuracy. Stock solutions for accuracy spikes and QC standards (if possible) shall be traceable to a source independent from the calibration standards. Accuracy is calculated using the following equation:

$$\%R = \frac{SSR - SR}{SA} = 100$$

Where:

%R	=	% recovery
SSR	=	spike sample result
SR	=	sample result
SA	=	amount of spike

14.3 DATA COMPLETENESS

Completeness is evaluated by dividing the total number of verifiable data points by the maximum number of data points possible and expressing the ratio as a percent. A usability criteria of 90 percent has been set for this project. The equation used for completeness is presented below:

$$C\ (\%) = \frac{D}{P \times n} \times 100$$

Where:

D	=	number of confident quantifications
P	=	number of analytical parameters per sample requested for analysis
n	=	number of samples requested for analysis

15.0 CORRECTIVE ACTION

When field sampling activities or laboratory QC results show the need for corrective action, immediate action will take place and will be properly documented. In the event that a problem arises, corrective action will be implemented. Any error or problem will be corrected by an appropriate action which may include:

- Replacing or repairing a faulty measurement system;
- Discarding erroneous data;
- Collecting new data; and
- Accepting the data and acknowledging a level of uncertainty.

15.1 FIELD SAMPLING CORRECTIVE ACTION

The on-site Principle Investigator will be responsible for all field QA. Any out of protocol occurrence discovered during field sampling will be documented in the field logbook and immediate corrective action will be taken. For problems or situations which cannot be solved through immediate corrective action, the Principle Investigator will immediately notify the AGC Project Manager. The AGC Project Manager and Principle Investigator will investigate the situation and determine who will be responsible for implementing the corrective action. Corrective action will be implemented upon approval by the AGC Project Manager. The Project Manager will verify that the corrective action has been taken, appears effective, and at a later date, verify that the problem has been resolved. The successfully implemented corrective action will be documented in the field logbook by the on-site Principle Investigator. Any deviations from the QA protocol in the SAP must be justified, approved by the AGC Project Manager (and IDEM and the USEPA, if necessary), and properly documented.

15.2 LABORATORY SITUATION CORRECTIVE ACTION

Corrective action will be implemented to correct discrepancies found which affect the validity or quality of analytical data, and to identify any analytical data that may have been affected. Limits of data acceptability for each parameter and sample matrix are addressed in the instrument manuals, USEPA Methods and/or Laboratory QA Manual. Whenever possible, immediate corrective action procedures will be employed. All analyst corrective actions are to be followed according to the instrument manuals, USEPA Methods, or Laboratory QA Manual. Any corrective action performed by the analyst will be noted in laboratory logbooks.

Laboratory personnel noting a situation or problem which cannot be solved through immediate corrective action will notify the Laboratory QA Supervisor. The QA Supervisor will investigate the extent of the problem and its effect on the analytical data generated while the deficiency existed. All data suspected of being affected will be scrutinized to determine the impact of the problem on the quality of the data. If it is determined that the deficiency had no impact on the data, this finding will be documented. If the quality of the analytical data were affected, the Laboratory Program Manager and the sample generator's Project Manager will be notified immediately so that courses of action may be identified to determine how to rectify the situation.

The laboratory must take corrective action if any of the QC data generated during the laboratory analyses are outside of the method criteria. Corrective action for out-of-control calibrations is to recalibrate the instrument and re-analyze the samples. A sequence is specified in the USEPA specified methods when problems in analyses are encountered. The laboratory will follow these procedures exactly and document the problems encountered and the corrective action in a case narrative enclosed with each data deliverables package.

The Laboratory QA Supervisor will be responsible for informing the Laboratory Program Manager and sample generator's Project Manager of the effects on the data, the data affected and the corrective action taken. It is also the Laboratory QA Supervisor's responsibility to verify that the corrective action was performed, appears effective, and at a later date, the problem was resolved.

15.3 DATA VALIDATION QA CORRECTIVE ACTION

Upon completion, sample data packages will be sent from the laboratory to the sample generator's QA Scientist for data validation. If all project samples are not present in the data packages or any deficiencies affecting the sample results are noted, the QA Scientist will contact the Laboratory QA Supervisor. The Laboratory QA Supervisor will respond in writing to any inquiries and provide any changes to the data packages to the QA Scientist. Any errors, problems, questionable data values, or data values outside of established control limits will be corrected by the appropriate action which may include disregarding erroneous data, collecting new data, and accepting the data and acknowledging a level of uncertainty. The data validation report will provide a description of the usability of the data.

TABLE 1
SAMPLING PARAMETERS AND REPORTING LIMITS
RMC Beechgrove, Indiana

LOCATION	MATRIX	METHOD	PARAMETER	RL	DQO	UNITS
HWMU	Soil/Sediment	SW-846 6020A[1]	Antimony	0.2	37	mg/kg
		SW-846 6010B[1]	Arsenic	1	20	mg/kg
			Cadmium	0.5	77	mg/kg
			Lead	0.3	970	mg/kg
			Selenium	0.5	53	mg/kg
outside HWMU, but still onsite		SW-846 6010B[1]	Lead	0.3	920	mg/kg
Offsite		SW-846 6010B[1]	Lead	0.3	400	mg/kg
Monitoring Well Installation		SW-846 9045	pH	NA	NA	S.U.
		US EPA 2480D	eH	20	NA	millivolts
		SW-846 6020A	Antimony	0.2	37	mg/kg
		SW-846 6010B	Aluminum	20	NA	mg/kg
			Arsenic	1	20	mg/kg
			Barium	20	NA	mg/kg
			Beryllium	0.5	NA	mg/kg
			Cadmium	0.5	77	mg/kg
			Calcium	500	NA	mg/kg
			Chromium	1	NA	mg/kg
			Cobalt	5	NA	mg/kg
			Copper	2.5	NA	mg/kg
			Iron	10	NA	mg/kg
			Lead	0.3	970	mg/kg
			Magnesium	500	NA	mg/kg
			Manganese	1.5	NA	mg/kg
			Nickel	4	NA	mg/kg
			Potassium	500	NA	mg/kg
			Selenium	0.5	53	mg/kg
			Silver	1	NA	mg/kg
			Sodium	500	NA	mg/kg
			Thallium	1	NA	mg/kg
			Vanadium	5	NA	mg/kg
			Zinc	5	NA	mg/kg
		SW-846 7471	Mercury	0.1	NA	mg/kg
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	0.4	NA	mg/kg
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	0.5	NA	mg/kg
		Walkley Black	Total Organic Carbon	1000	NA	mg/kg
		SW-846 9056	Sulfate	10	NA	mg/kg
		ASTM D422-63	Gradation (Sieve and Hydrometer)	NA	NA	NA

TABLE 1
SAMPLING PARAMETERS AND REPORTING LIMITS
RMC Beechgrove, Indiana

LOCATION	MATRIX	METHOD	PARAMETER	RL	DQO	UNITS
Containment Cell Monitoring	Aqueous	SW-846 6010B	Total and Dissolved Lead	1	15	µg/L
			Total and Dissolved Arsenic	1	10	µg/L
		SW-846 6020A	Total and Dissolved Antimony	2	6	µg/L
		SW-846 9040	pH	NA	NA	S.U.
		SW-846 9060	Total Organic Carbon	1	NA	mg/L
MNA	Aqueous	SW-846 6010B	Total and Dissolved Lead	1	15	µg/L
			Total Iron	50	NA	µg/L
			Total and Dissolved Arsenic	1	10	µg/L
		SW-846 9034	Sulfide	3	NA	mg/L
		SM 4500 SO3 B	Sulfite	5	NA	mg/L
		US EPA 300.0	Nitrate	0.1	NA	mg/L
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	2	10	µg/L
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	50	NA	µg/L
		Applied Speciated propriatary method	Manganese speciation (MnII/MnVII)	NA	NA	µg/L
Equipment Blanks	Aqueous	SW-846 6020A[1]	Total and Dissolved Antimony	2	NA	µg/L
		SW-846 6010B[1]	Total and Dissolved Arsenic	1	NA	µg/L
			Total Cadmium	1	NA	µg/L
			Total Iron	50	NA	µg/L
			Total and Dissolved Lead	1	NA	µg/L
			Total Selenium	5	NA	µg/L
		SW-846 9040	pH	NA	NA	S.U.
		SW-846 9060	Total Organic Carbon	1	NA	µg/L
		SW-846-9034	Sulfide	3	NA	µg/L
		SM 4500 SO3 B	Sulfite	5	NA	µg/L
		US EPA 300.0	Nitrate	0.1	NA	µg/L
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	2	NA	µg/L
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	50	NA	µg/L
		Applied Speciated propriatary method	Manganese speciation (MnII/MnVII)	NA	NA	µg/L

Notes:
Antimony will be analyzed by SW-846 6020A
µg/L: micrograms per liter RL: Reporting Limit
mg/L: milligrams per liter DQO: Data Quality Objective
mg/kg: milligrams per kilogram N/A: not applicable

[1]USEPA "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", Feb. 2007, SW-846, 6th Revision.

ATTACHMENT H

Monitored Natural Attenuation Work Plan
Replacement Pages

MONITORED NATURAL ATTENUATION WORK PLAN

Prepared For:

REFINED METALS CORPORATION
Beech Grove, Indiana

Prepared By:

ADVANCED GEOSERVICES
West Chester, Pennsylvania

Project No. 2003-1046-18
October 6, 2010
Revised March 21, 2011

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APPENDIX

1.0 PURPOSE

This Monitored Natural Attenuation Work Plan (MNA Work Plan) is intended to present a description of the Hydrogeologic Conceptual Site Model; a summation of sampling results for the shallow perched groundwater zone as observed during the RCRA Facility Investigation (RFI) and Closure Investigation; proposed MNA data collection requirements; and procedures for MNA data evaluation and reporting at the former Refined Metals Corporation (RMC) facility located on South Arlington Avenue in Beech Grove, Indiana. This MNA Work Plan is intended to provide supplemental information specific to groundwater as an Attachment to the Corrective Measures Design (CMD) Report.

As discussed in Section 5.0 of the CMD Report and specified in the Media Cleanup Standards section of the Statement of Basis (USEPA, June 2008), the corrective measure for the RMC facility will involve the excavation of soil and sediment with the highest lead and arsenic concentrations and consolidation within a containment cell with a low-permeability cover, and MNA of shallow perched groundwater. The proposed soil and sediment excavation activities being performed as part of the Corrective Measures will involve the removal of approximately 6,000 cubic yards of on-site material and achieve a Preliminary Remediation Goal for lead of 920 mg/kg. As part of the Hazardous Waste Management Unit (HWMU) Closure, nearly 5,000 cubic yards of soil will be remediated to achieve the post remediation level of 970 mg/kg for lead and 20 mg/kg for arsenic, as well as the IDEM RISC Industrial Closure Levels for antimony (37 mg/kg), cadmium (77 mg/kg) and selenium (53 mg/kg). The Baseline Human Health Risk Assessment (BHHRA) demonstrated that excavation of the soils with concentrations of lead above the calculated Remedial Action Level (RAL) will result in a post-remediation cancer risk from arsenic ranging from 1×10^{-6} to 7×10^{-6} and a post remediation hazard quotient between 0.03 and 0.2.

The MNA Work Plan is organized as follows:

2.0 HYDROGEOLOGIC CONCEPTUAL SITE MODEL

2.1 PHYSICAL SETTING

The Site is located in the White River Drainage Basin. The Site is situated on a minor local topographic high with a surface elevation of approximately 845 feet above mean sea level (msl). The surface elevation slopes gently to the southeast toward Sloan Ditch, and the northwestern perimeter of the Site slopes to the northwest toward the intermittent headwaters of Beech Creek.

Surface water from the northern portion of the site flows to a drainage ditch along the CSX railroad tracks that eventually runs into an intermittent stream that flows northwest to the headwaters of Beech Creek. Surface water from the eastern and southern areas on the Site historically flowed to the south, eventually discharging to Sloan Ditch. Sloan Ditch flows 0.6 mile west-southwest to Churchman Creek, which flows to the west 0.9 mile and discharges to Beech Creek. Beech Creek flows 1.2 miles to the southwest to Lick Creek, which then flows 7 miles to the White River. Beginning in the early 1980s and continuing until May 2010 storm water runoff from the manufacturing areas of the site was collected, treated as required and discharged to the City of Indianapolis POTW. In the spring of 2010 (following site decontamination and demolition activities), RMC submitted a "No Exposure Certification", which included the results of post decontamination and demolition storm water sampling, for the storm water to IDEM and on May 7, 2010 received a determination that the site is no longer required to manage storm water runoff under IDEM Rule 6 (regarding storm water runoff from industrial activities). Since receipt of that determination, RMC has been discharging storm water collected from the former manufacturing areas into the drainage ditch that drains the northern portions of the site.

2.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

The surficial geology of Marion County is glacial till (Tipton Till Plain) consisting of yellowish-gray, bluish-gray, or gray sand or silt with some clay and pebbles and scattered cobbles and boulders. The drift cover in Marion County is believed to be composed of three drift sheets resulting from the Kansan, Illinoian, and Wisconsin glaciations. Thickness of the glacial till in the region range from less than 15 feet to greater than 400 feet. The Site is underlain by approximately 200 feet of unconsolidated material. Bedrock is encountered at an elevation of approximately 640 feet mean sea level (on the order of 200 feet bgs), and consists of middle Devonian-aged dolomitic limestones. The limestones consist primarily of the Geneva Dolomite and the Jefferson Limestone. The Geneva Dolomite is a light gray to tan and buff to chocolate brown dolomite that contains white crystalline calcite masses. The Jeffersonville Limestone is a pure limestone in the upper portion of the formation, and is laminated with organic material in the lower portion. The organic laminae are more argillaceous than the coralline zone (Harrison, 1963). Meyer, 1975 indicates that shale is present beneath the glacial till and overlying the limestones. Additional detail on the shale unit is not provided by Meyer. The regional dip is to the southwest so that progressively younger formations are encountered below the till plain to the southwest.

Regionally, groundwater is encountered in un-named sand and gravel beds overlying the bedrock, the Jefferson Limestone and Geneva Dolomite, and the Niagaran Limestones (Harrison, 1963). The sand and gravel glacial outwash that coincides with the courses of the White River and Fall Creek is the aquifer of greatest economic importance in Marion County. The location of this aquifer generally coincides with the glacial melt water and outwash deposits along the major streams. Fall Creek enters White River upstream of the Site. The White River sand and gravel aquifer is located approximately 5.3 miles west of the Site.

It is noted by Meyer that three thin, aerially discontinuous, sheet-like deposits of sand and gravel in the till-plain area are separated by beds of silt and clay that cause the groundwater in these deposits to be semi-confined. Meyer also notes that large areas of silt and clay often separate one area of an aquifer from another. The elevation of the uppermost semi-confined aquifer beneath the Site was estimated to be approximately 720 ft msl (approximately 120 feet bgs) and is overlain by deposits of varying thickness of silt and clay, however; as discussed below the uppermost semi-confined aquifer was not encountered during site investigations activities which included boring to 130 feet deep. Groundwater flow in the uppermost regional semi-confined aquifer is reported to be towards the northwest. The middle regional semi-confined aquifer is not mapped beneath the Site because an aquitard (clay unit) is mapped in the area. The elevation of the lower regional semi-confined aquifer in the vicinity of the site is mapped at approximately 660 ft msl (180 ft bgs) with flow towards the southeast.

The average daily industrial and municipal groundwater pumpage for Marion County is 28.95 million gallons per day (mgpd). Less than 20 percent of the industrial/municipal pumpage is from the bedrock. Also, less than 20 percent of the total pumpage is obtained outside the unconfined glacial-outwash aquifer which occurs only along the White River and Fall Creek and is located at least 5.3 miles west of the Site. The major centers of groundwater pumpage occurred within approximately one mile of a major stream. The estimated total domestic groundwater pumpage is 9.0 to 11.0 mgpd (Meyer 1975).

2.3 SITE SPECIFIC GEOLOGY AND HYDROGEOLOGY

Based on results of the RFI activities, the surficial geology at the Site is consistent with the regional geology described in Section 2.2. Shallow surface conditions beneath portions of the Site have been altered as part of original facility construction and subsequent expansion activities. Several topographic high mounds in the wooded area northeast of the manufacturing area and adjacent to the intermittent stream/stormwater drainage ditch are believed to be fill material from on-site construction activities. Similarly, paved areas and areas below the structures on-site have been filled with gravel (i.e. subbase) at thicknesses ranging from 6 to 12 inches.

Four deep borings identified as MW-1D, MW-2D, MW-3D and MW-6D were advanced on-site to depths ranging from 110 feet to 130 feet bgs during the Phase I RFI to characterize subsurface conditions. Borings MW-2D and MW-6D were subsequently converted into monitoring wells as discussed below. The logs for these four deep borings are attached in Appendix A. The screened interval for MW-2D and MW-6D were set in a middle perched zone located 75 to 85 feet below grade. Stratigraphy typically varies from clayey silt to sandy silt, occasionally grading into clay or sand. When encountered, zones of clay or sand were generally thin and laterally discontinuous. The only notable exception was a clay layer encountered in all four deep borings that ranged in thickness from 7 to 12 feet at depths between 50 and 60 feet below ground surface (bgs). A second clay zone was encountered in each of the deep borings at depths typically between 90 and 100 bgs. The thickness of the till plain beneath the Site is at least 110 to 130 feet and the uppermost semi-confined regional aquifer was not encountered in any of the deep borings.

Shallow groundwater encountered at the Site represents a local perched zone of saturation in silty sand and sand layers within the glacial till. The four deep and seven shallow borings advanced during the RFI and CMS, and the five shallow boring logs advanced prior to installation of site monitoring wells MW-1 through MW-5 in 1991 (see Appendix A) indicate that the sand layers vary in thickness and elevation throughout the Site. The piezometric surface for the shallow on-site wells is represented by depth to groundwater measurements obtained during groundwater sampling performed on December, 2001 (Figure 1) and January, 2007 (Figure 2) and are similar to other sampling events. As shown, groundwater flow in the shallow on-site wells appears to be to the southeast beneath the former manufacturing areas (an area covered with buildings and pavement) and towards the east-northeast beneath the areas north of the former manufacturing area. The piezometric surface for the shallow perched groundwater on-site is less than 5 feet bgs and suggests a semi-confined or confined condition when compared against the higher permeability zones noted in the well boring logs. Southeast of the former manufacturing area, shallow groundwater flow heads south. The change in flow appears to be the result of greater amounts of infiltration occurring in the poorly drained grass areas between Arlington Avenue and the former manufacturing area. The area in the general vicinity of MW-11 will typically have standing water.

2.4 AQUIFER CHARACTERISTICS

Sieve analysis performed on shallow wells (MW-6SR, MW-8 and MW-9) installed during the Phase II RFI identified all samples analyzed as sandy silt or silt with sand (USCS Class ML). The vertical coefficient of permeability calculated from Triaxial Variable Head Permeability Test was 4.90 x 10^{-9} cm/sec from MW-6SR at 10-12 feet (above the screened interval) and 4.03 x 10^{-8} cm/sec for MW-6SR at 16-18 feet (within the screened interval). Undisturbed samples collected from MW-7 and MW-9 could not be analyzed for permeability because of material characteristics therefore sample analysis was limited grain size analysis. The grain-size distribution curves for the samples from MW-7 and MW-9 were very similar to the MW-6SR 16-18 foot sample and would be expected to have similar permeability.

Depth to groundwater measurements show a northwest to southeast gradient for the shallow perched zone beneath the manufacturing portions of the site ranging from <0.01 ft/ft to approximately 0.02 ft/ft. In the lawn area between the paved manufacturing area and South Arlington Avenue depth to groundwater measurements indicate a northeast to southwest gradient. As stated above, this is believed to be the result of greater amounts of infiltration occurring in the poorly drained lawn area. Where the northwest to southeast gradient beneath the paved manufacturing areas meets the northeast to southwest gradient from the lawn area, the shallow perched groundwater flow assumes a north to south flow direction.

Shallow groundwater conditions have been evaluated through the installation and sampling of twelve (12) shallow monitoring wells. Monitoring well locations are shown on Figures 1 and 2. Groundwater in the shallow zone of saturation beneath the former manufacturing area occurs as perched zones within thin, laterally discontinuous layers of sand and sandy silts contained in clayey-silt and silty-clay glacial deposits.

2.5 EXPOSURE PATHWAYS

Potable water in the vicinity of the Site is provided by a public water service; therefore, private use of the water beneath the Site is not an exposure pathway. The groundwater monitored by the MNA program is a perched zone located a few feet below the ground surface. This perched zone is limited in areal extent and does not provide flow rates sufficient enough for household or industrial use and is not used for the public water supply.

The perched zone beneath the Site discharges to adjacent swales during periods of high water table. This is a potential exposure pathway to surface water.

3.0 SUMMARY OF PREVIOUS GROUNDWATER SAMPLING

The results of groundwater sampling conducted as part of the RFI, Closure Investigation and CMS are provided in Tabular format on Tables 1A through 1L in the Corrective Measures Design Report. Field parameters for all wells are also provided in Tables 1A through 1L. Groundwater sampling performed as part of the RCRA Facility Investigation (RFI) and Closure Investigation have identified lead above 42 ug/L (IDEM Industrial Default RISC Criteria) in unfiltered groundwater samples on more than one occasion in groundwater monitoring wells MW-2 and MW-7. Investigation activities have identified arsenic above 10 ug/L (MCL and IDEM Industrial Default RISC Criteria) in filtered (i.e., dissolved) and unfiltered groundwater samples on more than one occasion in groundwater monitoring wells MW-1, MW-7 and MW-8, and on more than one occasion in only unfiltered samples in MW-2S, MW-3 and MW-10. A graphical presentation of filtered and unfiltered results for lead and arsenic for all the wells are presented on Figures 3A, 3B, 4A and 4C. Figure 2 provides isoconcentration lines for unfiltered lead and arsenic results for the January 2007 groundwater sampling event..

4.0 TECHNICAL BASIS FOR MONITORED NATURAL ATTENUATION

Results of the groundwater sampling did not reveal site-wide groundwater impacts; however, results did detect arsenic and lead above the screening levels utilized for this project in multiple samples from several wells. Therefore, USEPA has requested that shallow groundwater be included as a component of the Corrective Measures for the site and Monitored Natural Attenuation (MNA) has been selected as the remedy.

4.1 POTENTIAL SOURCE AREAS

4.1.1 Outdoor Feed Pile Storage Areas

As represented on Figures 1 and 2, the areas that lead exceeds the IDEM Industrial Default RISC Criteria and arsenic exceeds the MCL coincide with those areas of the site where the most intensive activities associated with the recycling operations occurred. Site operations consisted of recycling lead acid batteries to recover the lead. During the early operations (prior to 1984) battery breaking, the process used to separate the lead cores from the electrolyte (dilute sulfuric acid) and the casings, was conducted off-site and only the lead bearing components (grids, posts and oxide paste) were delivered to the site for smelting and refining. Materials received for processing were managed in piles prior to being fed into the furnace. The piles were situated on unpaved areas within the footprint of the Hazardous Waste Management Units (HWMUs) identified as the "Outdoor Waste Piles" or "Material Storage Building".

Beginning in 1984 and continuing until the end of facility operations in 1995, the site operated its own battery breaker, which included cutting or breaking open the batteries; separating the casings for off-site plastics recycling; collecting and neutralizing the acid prior to discharge to the POTW; and retaining the lead bearing components for smelting and refining. Facility improvements completed during the mid to late 1980s included paving site and eventually included the elimination of managing feed material outdoors.

Management of feed materials in outdoor piles is believed to be the most significant period of facility operations for impacting the shallow perched groundwater. The piles provided both a source for lead and arsenic and a mechanism capable of dissolving and transporting them into the subsurface (i.e., precipitation reacting with residual acid contained in the feed materials causing leaching).

4.1.2 Impacted Surface Materials

Sampling conducted in the area north of the battery breaker building and material storage building (representing outdoor waste piles 1 and 2 and containing MW-2, MW-7 and MW-8) identified fill materials with the highest concentrations of lead (up to 475,000 mg/kg) and arsenic (up to 2,730 mg/kg) on-site. These fill materials are believed to be a combination of residual amounts of the feed materials managed in the outdoor waste piles and filling performed as part of the grading required to internalize site storm water drainage.

Although with significantly lower concentrations of lead and arsenic relative to the area north of the battery breaker building, the unpaved area in vicinity of MW-1 was identified to contain shallow surface soils with lead up to 32,000 mg/kg and arsenic up to 359 mg/kg. These materials are believed to be the result of minor filling with contaminated soils. This area has been unpaved throughout the operating history of the facility and would have been susceptible to infiltrations that could potentially mobilize and infiltrate lead and/or arsenic.

4.2 PROPOSED SOURCE REMOVAL

The potential source areas for lead and arsenic impacts on groundwater are presented on Figures 1 and 2. Although not believed to be as significant a contributor as the outdoor waste pile area (because the area was under roof), we have also included the material storage building as a potential source area since lead bearing material was actively managed in this area and the floor was observed to be in poor condition at the time of facility closure. As shown on the Corrective Measures Design Drawings, the primary remedial activity will be the excavation of the most highly impacted soils at the site, including extensive excavation activities in the areas identified as potential source areas.

Based on a limited amount of SPLP Testing (USEPA Method 1312) conducted during the Corrective Measures Study, the average partitioning coefficients for lead and arsenic were 6,901 L/kg and 3,917 L/kg respectively. Utilizing these results and the IDEM Industrial Default RISC Criteria for arsenic and lead in groundwater in a Soil to Groundwater Partitioning Model with a ½ acre area (DAF = 20); the soil concentrations with the potential to cause unacceptable impact to groundwater are approximately 5,800 mg/kg lead and 780 mg/kg arsenic.

Following completion of soil remediation within the area in vicinity of MW-1, the average remaining lead and arsenic concentrations will be less than 800 mg/kg and 15 mg/kg, respectively. The locations of the former outdoor waste pile and material storage building areas will have even lower post remediation concentrations. Source removal, in the form of the proposed soil and sediment remediation activities is a critical component for realizing successful natural attenuation.

5.0 MNA DATA COLLECTION

5.1 GENERAL

Based on the results of previous groundwater sampling, the hydrogeologic conceptual site model, and an understanding of the operating history of the facility; the area of site groundwater that will be the subject of MNA has been delineated as shown on Figure 2. Monitoring activities will involve establishing a network of wells capable of providing information regarding the potentiometric surface and groundwater quality over time. A description of the proposed network and procedures for obtaining reliable information regarding groundwater elevations and representative analytical data is provided in the following sections.

The Sampling and Analysis Plan is provided as Appendix D of the Construction Quality Assurance Plan, and includes the Quality Assurance Project Plan components relative to groundwater sampling.

5.2 GROUNDWATER SAMPLING LOCATIONS

As described above, the shallow perched groundwater zone has been monitored using 12 monitoring wells installed between 1990 and 2005. To the extent practicable, the groundwater sampling locations to be utilized for MNA will rely on existing monitoring wells. Specifically, existing wells MW-1, MW-2, MW-3, MW-8, MW-9 and MW-12 will be utilized as part of the MNA sampling network. In addition, the proposed monitoring wells CC-1 through CC-6 will serve the dual purpose of monitoring the containment cell and being part of the MNA sampling network. Figure 2 presents the proposed groundwater monitoring network. These wells have been selected as they bound the MNA monitoring zone as depicted on Figure 2. Existing wells MW-7 and MW-10 are not included as part of the proposed MNA sampling network because they are located in the prepared containment cell location and are proposed for abandonment as part of the proposed corrective measures. Abandonment will be performed in accordance with the requirements of IDEM and Marion County Indiana. Well CC-6 will be installed at a location in the nearest downgradient location from the MW-7 and MW-10 locations which is outside the prepared containment cell footprint and will provide ample groundwater data for this area.

Proposed wells CC-1 through CC-6 will be installed during the corrective measures implementation after the containment cell berms and perimeter access roads have been constructed. During installation of CC-1 through CC-6, at least two (2) soil samples will be collected for chemical analysis from each boring. The data will be used for geochemical modeling, if needed. The one sample each will be collected from the unsaturated overburden soils and from within the proposed screen horizon in each boring utilizing split spoon sampling techniques. Soil samples will be submitted for laboratory pH and eH, target analyte list (TAL) metals, arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), total organic carbon and sulfate. Samples from the same depth/intervals will also be submitted for gradation (sieve and hydrometer analysis). Permeability testing will be performed in existing wells MW-1, MW-2, MW-8 and MW-9 and proposed wells CC-1, CC-3 and CC-6. Permeability testing shall be performed using slug tests (ASTM D4044 - 96(2008)).

5.3 WATER LEVEL MEASUREMENTS

At the start of each MNA groundwater sampling event, depth to water measurements will be obtained in general accordance with the American Society of Testing Materials (ASTM D 4750-97) procedures from all on-site wells. Depth to water measurements and date and time of measurement will be recorded to the nearest 0.01 ft in a bound field log book by the Technician performing the measurements. The total depth of the well will also be recorded (after the completion of groundwater sampling). At the time of gauging the field technician will also make any notations regarding the condition of the wells (including unsecured, broken or missing locks).

Depth to water level measurements will be taken from an established point at the top of the PVC riser pipe. Depth to water measurements will be obtained by carefully lowering an electronic water level indicator avoiding contact with the casing to the extent possible. The water level indicator probe will be decontaminated between each well. Additional information regarding the collection of water level measurements are included as part of the Sampling and Analysis Plan.

Results of the depth to groundwater level measurements will be used to develop a potentiometric groundwater contour map for the shallow perched groundwater. Addition of the proposed CC wells will also allow refinement of groundwater flow in the northern portions of the site.

5.4 MONITORED NATURAL ATTENUATION GROUNDWATER SAMPLING FREQUENCY

The MNA groundwater monitoring wells will be sampled beginning approximately one month following installation of the proposed containment cell monitoring wells. Sampling will be performed once every calendar quarter for twelve consecutive quarters with the first evaluation regarding future frequency performed after completion of the second year of monitoring (i.e., after 8 quarters). Monitoring will end when the sampling results demonstrate that the remedial goals have been attained for four consecutive quarters. If analysis after the first 12 consecutive quarters indicate increasing concentrations, RMC will continue quarterly sampling while evaluating the observed results and developing an alternate strategy for mitigating impacts. Monitoring wells will be added to the MNA monitoring well network as necessary if increasing concentrations are detected in the existing monitoring wells.

Sampling and analysis of containment cell groundwater monitoring wells will continue at the frequencies established in the Corrective Measures Design Report even after cessation of MNA groundwater monitoring.

5.5 GROUNDWATER ANALYTIC PARAMETER

During the first two quarterly groundwater sampling events, samples will be analyzed for total and dissolved arsenic and lead, sulfide, sulfate, nitrate arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), and manganese speciation (MnII/MnVII) for use in geochemical modeling. Beginning after the second quarterly groundwater sampling event, groundwater analysis will be limited to total and dissolved lead and arsenic. If subsequent sampling events identify sustained concentrations of lead and arsenic above the criteria established in the CMI Work Plan and previous modeling has established that MNA should be occurring, then additional sampling events for sulfide, sulfate, nitrate arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), and manganese speciation (MnII/MnVII) may be conducted as needed and the modeling re-evaluated.. Field parameter readings to be recorded at the time of sample collection during all groundwater sampling events shall include temperature; pH; Eh; dissolved oxygen (DO); specific conductance and turbidity.

6.0 DATA EVALUATION AND REPORTING

6.1 GENERAL

Monitored Natural Attenuation (MNA) of inorganic constituents like lead and arsenic in most settings is predominantly the result of sorption, precipitation, oxidation/reduction, advection, dispersion and/or diffusion. For the RMC site, initial information regarding the properties of the perched groundwater zone indicates low permeability soils (even within the saturated zones) and significant amounts of clay. Groundwater sampling has identified site wide near neutral pH conditions, neutral to slightly positive ORP (typically <100 mV). Based on these observations sorption is expected to be the dominant MNA process that can be anticipated going forward.

6.2 INITIAL DATA EVALUATION

Following completion of the second quarterly groundwater sampling event, potentiometric groundwater contour maps for the first two sampling events will be developed. The maps will be provided as a figure in an initial report that also presents and discusses the results of groundwater analysis. The report will be submitted to EPA and will provide an initial interpretation of the observed results for both groundwater and aquifer testing including geochemical physical characteristics. The results of the initial analysis will be utilized to perform computational speciation modeling using PHREEQC2 or similar program. Results of the modeling will be included with the initial data evaluation report. The RMC property boundaries will be considered the point of compliance with evaluating the data.

Trends analysis will not be performed until after 4 rounds of post-remediation groundwater sampling results have been obtained. A side by side comparison of observed total and dissolved lead and arsenic concentrations will be performed as part of the initial evaluation.

6.3 ANNUAL REPORTING AND TREND ANALYSIS

Results for arsenic and lead will be evaluated annually beginning after the collection of the fourth sampling event. Results will be initially evaluated against their corresponding action levels (lead 42 ug/L and arsenic 10 ug/L) to identify those wells with observed exceedances. For those groundwater monitoring wells where exceedances are observed, a subsequent evaluation will be performed using the Mann-Kendall (M-K) test to evaluate trends in the data on a well by well basis to determine if the plume is expanding (concentrations increasing), shrinking (concentrations decreasing), or stable. The M-K test is a non-parametric test used to evaluate trends in small data sets that are not normally or log-normally distributed. The test usually requires a minimum of four consecutive sets of data to provide representative results.

The M-K test will provide S-statistics for a comparison to a desired probability of 0.1 (α). A probability of 0.1 has been selected because it implies that there is only a 10% chance that random fluctuations would suggest a trend when a trend does not actually exist and is considered an acceptable Type I error. Given the desire to minimize the possibility of a Type II error (i.e. concluding that no trend exists, when one does exist), alpha = 0.1 is considered reasonable and appropriate given the absence of groundwater receptors at the site.

The annual report will include quarterly groundwater contour maps, additive results table (i.e. including all previous results beginning after the completion of the proposed Corrective Measures), the results of statistical analysis, and arsenic and lead isoconcentration maps over multiple time intervals. Evaluations of compliance will be performed relative to concentrations at the RMC property boundary.

DESIGN NARRATIVE
Replacement Pages

FINAL CORRECTIVE MEASURE DESIGN

Prepared For:

REFINED METALS CORPORATION
Beech Grove, Indiana

Prepared By:

ADVANCED GEOSERVICES
West Chester, Pennsylvania

Project No. 2003-1046-18
October 6, 2010
Revised March 21, 2011

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Final CM Design
Refined Metals Corporation
Beech Grove, Indiana
March 21, 2011

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1.0 INTRODUCTION

1.1 GENERAL

Presented herein is the design report describing the proposed Corrective Measures to be completed by Refined Metals Corporation (RMC) to address elevated concentrations of lead and associated inorganic compounds in soil, sediment and groundwater identified on and around the RMC facility in Beech Grove, Indiana. The design report, in conjunction with the design drawings, specifications, Construction Quality Assurance Plan, and other attachments, comprises the Corrective Measures Design (CMD). The CMD is being submitted pursuant to the requirements of a Consent Decree negotiated between RMC, the United States Environmental Protection Agency (USEPA) and Indiana Department of Environmental Management (IDEM) Civil Action No. IP902077C.

This submission of the CMD is intended to represent a Final level of completion. The format and level of detail of the CMD process represent a hybrid between the highly structured requirements identified in the Consent Decree, and the single submission format requested in the Final Decision Document. As agreed upon between representatives of RMC, USEPA and IDEM, the Preliminary submission presented the major design components at approximately a 20 to 30% level of completion to obtain regulatory consensus. This Final submission has been developed to advance the amount of detail to a level of 100%. The general configuration of the major design components presented in the Preliminary submission (including containment cell location; excavation limits and confirmatory sampling techniques; pre and post-remediation storm water management strategies; and anticipated permitting requirements) have not changed. This submission includes attachments presenting construction specifications; Construction Quality Assurance Plan; Inspection and Maintenance Plan (including groundwater monitoring plan); engineering calculations; cost estimates; and construction schedule. The design drawings have been advanced to include additional details and schematics, sequence of construction information, and construction notes.

1.2 BACKGROUND

The Refined Metals Corporation (RMC) Beech Grove facility (Site) was the location of a secondary lead smelting and refining operation from 1968 through 1995. The general location of the Site is shown on Figure 1 and a detailed plan of the Site is shown on Sheet 1 of the design drawings. During its operational life, the facility handled hazardous materials or hazardous wastes under the Resource Conservation and Recovery Act (RCRA). These primarily consisted of lead acid automotive and industrial batteries, and lead-bearing materials that were processed for lead recovery.

In accordance with the requirements of RCRA, the facility completed and submitted a RCRA Part A permit application. On November 19, 1980 the facility was granted approval to operate two hazardous waste management units under Interim Status: 1) indoor waste piles; and 2) outdoor waste piles. Facility documents also identify a surface impoundment (lagoon) as a RCRA permitted unit; however, the lagoon does not appear to have been included on the Facility Part A permit until after 1991. The lagoon was, and still is, used to collect and manage facility storm water runoff. See Sheet 1 of the design drawings for the location of the RCRA Hazardous Waste Management Units (HWMUs).

The former indoor and outdoor waste piles were removed when normal facility operations ceased. The site sat idle after December 31, 1995 except for the wastewater treatment system which remained in operation to collect and manage storm water runoff from the lagoon and other site areas. Between August 2009 through early-January 2010, all buildings and structures were decontaminated and demolished, with the exception of four pump houses and the lagoon which remained in operation for on-site storm water management. Decontamination and demolition activities were performed in accordance with the *Draft Decontamination and Demolition Plan* (Advanced GeoServices March 4, 2009) and the *Decontamination and Demolition Implementation Plan* (Focus Contracting, June 8, 2009) both of which were submitted, reviewed and approved by the USEPA and IDEM. A summary report of the decontamination and demolition activities is being prepared on a parallel track with preparation of this CM Design submission and will be included as an attachment to the Corrective Measures Completion Report to be provided following completion of the Corrective Measures. The summary report will describe the methods utilized for decontamination, the waste streams produced (including estimated quantities) and identify the final disposition (disposal or recycling) of the materials generated.

Throughout the decontamination and demolition process, storm water from the impervious former manufacturing area continued to be collected, treated as appropriate, and discharged to the City of Indianapolis POTW. The impervious ground surfaces within the former manufacturing areas (former pavement surfaces and remnant floor slabs) were cleaned as part of the decontamination and demolition activities. Storm water inlets/manholes, piping and pump house sumps were cleaned following final cleaning of the impervious Site surface areas to remove sediment and rinse water what may have been washed into the storm water system.

Storm water sampling performed after completion of site cleaning activities has demonstrated that storm water from the lagoon and cleaned surface areas of the site can be discharged without requiring pre-treatment. In an effort to reduce the hydraulic loading on the POTW, the City of Indianapolis requested that RMC cease discharge of the clean storm water to the sanitary sewer following completion of decontamination and demolition activities. In response, RMC submitted a request for a "No Exposure Certification for Exclusion from NPDES Storm Water Permitting" to allow surface discharge of the storm water been sent to the POTW. IDEM approved the request in May 2010 and since that time RMC has discharged storm water to the drainage ditch at the north end of the property using the existing system of pumps and internal conveyance piping. The existing pump houses and collection system (inlets and piping) will be demolished and/or sealed/plugged and the site regraded to gravity drain storm water as part of the corrective measures and HWMU closure site restoration activities. Demolished components will be salvaged (pumps and controls), recycled, and or disposed in the containment cell.

1.3 PURPOSE

On August 31, 1998 Refined Metals Corporation entered into a Consent Decree with the United States Environmental Protection Agency (USEPA) and the Indiana Department of Environmental Management (IDEM), Civil Action No. IP902077C. The technical objectives of the Consent Decree are as follows:

1. Effectuate closure of waste piles and surface impoundment by submitting a closure plan and post-closure plan, if necessary, and then to implement the plan(s) as approved;

2. Perform a RCRA Facility Investigation (RFI) to evaluate and determine the full nature and extent of releases and collect information necessary to support a Corrective Measures Study, or Interim Measures;

3. Perform Interim/Stabilization Measures to abate threats to human health and the environment;

4. Perform a Corrective Measures Study to develop and evaluate alternatives and to recommend a final corrective measure(s); and,

5. Perform Corrective Measures.

1.3.1 Waste Pile and Surface Impoundment Closure Investigations

Pursuant to Section VI, Paragraph 37 of the Consent Decree (Compliance Requirements for Closure), Advanced GeoServices Corp. (AGC) prepared a Closure Plan on behalf of RMC for the HWMUs. The Closure Plan was prepared in accordance with Indiana Department of Environmental Management (IDEM) Hazardous Waste Management Unit Closure Guidance (Waste-0013-ND) and Risk Assessment Addendum.

The Closure Plan (Version 3.0 dated July 17, 1999) was implemented between the fall of 1999 and spring of 2000. The results of the investigation conducted pursuant to the approved Closure Plan were presented in the Closure Investigation Report (AGC, June 2000). Comments on the Closure Investigation Report prompted additional soil sampling within the HWMUs in December 2001, January 2007 and August 2007. Results of the Closure Investigation activities were compiled in a Comprehensive Closure Investigation Report (AGC March 27, 2007), with an addendum containing supplemental sampling information on January 29, 2008 and a response to IDEM comments on April 8, 2008.

1.3.2 RCRA Facility Investigation

Pursuant to Section VI, Paragraph 42 of the Consent Decree (Compliance Requirements for Corrective Action), RMC prepared and implemented a RCRA Facility Investigation (RFI) Work Plan (AGC March 3, 1998) which was conditionally approved by the USEPA in writing on June 3, 1999. The RFI Work Plan was revised by AGC on July 7, 1999 in response to the USEPA conditional approval. Final USEPA approval of the RFI Work Plan was received in a letter dated August 17, 1999. The USEPA approved RFI Work Plan was implemented by AGC on behalf of RMC in late 1999 and early 2000. A Phase I RFI Report was submitted by RMC on August 31, 2000. Based on the results of the Phase I RFI and as required by the USEPA, a Phase II RFI Work Plan was prepared and submitted (AGC December 20, 2000). Following minor revisions (based on USEPA comments) in an addendum dated June 27, 2001, the Phase II RFI Work Plan was approved by the USEPA on July 13, 2001. The Phase II RFI Report was prepared and submitted by AGC on May 3, 2002 and subsequently revised in November 18, 2002.

1.3.3 Interim Corrective Measures

Results of the Phase I RFI identified elevated concentrations of lead in the shallow surface soil/sediment along the former railroad spur entering the facility from the railroad tracks north of the site. To reduce the potential for that soil/sediment to be eroded and transported to areas off-site RMC prepared a Interim Measures Work Plan (AGC December 20, 2000), consisting of a series of check dams across the drainage ditch that was approved by the USEPA on July 13, 2001. AGC implemented the Interim Measures Work Plan in September 2001. Those measures remain in-place to date and based on visual observations provide detention and filtration to storm water flow in the ditch. The check dams will remain in-place until remediation is performed in the drainage ditches on either side of the railroad spur. No other interim measures were performed or required at the facility.

1.3.4 Corrective Measures Study

The Corrective Measures Study (CMS) was performed in two phases pursuant to a CMS Work Plan (AGC April 21, 2003), as revised by AGC on July 11, 2003 and October 16, 2003 and conditionally approved by USEPA on November 5, 2003. The Phase I CMS consisted of supplemental soil sampling (including shallow surface soil in the mowed grass swale along South Arlington Avenue and drainage ditch along the CSX railroad tracks referred to in the RFI, CMS and herein as "sediment") and groundwater sampling (completed by AGC during the fall of 2003), and completion of a Baseline Human Health Risk Assessment (BHHRA) (performed by Gradient Corporation (Gradient)). The BHHRA separated the site into two exposure areas identified as "Grassy Areas" and "On-Site Areas". Figure 2 shows the specific areas represented by Grassy Areas and On-Site Areas. The results of the Phase I CMS were initially submitted in a report prepared by AGC on June 22, 2004. The USEPA issued written comments on August 17, 2004 and January 18, 2005 and the Phase I CMS Report was revised on May 6, 2005 and approved in writing by the USEPA on August 23, 2005.

The Phase II CMS consisted of the development and evaluation of cleanup options for those areas of the site impacted above action levels established in the BHHRA and accepted in writing by the USEPA in their approval letter dated August 23, 2005. The Phase II CMS also anticipated remediation of surface soils and sediment with total lead concentrations >400 mg/kg in the right-of-way for South Arlington Avenue, Citizens Gas property along the south side of the Citizens Gas security fence parallel Big Four Road, and drainage ditch within the CSX right-of-way. The Phase II CMS Report was originally submitted by AGC on October 21, 2005. The Phase II CMS Report was revised by RMC through a series of iterations promulgated by USEPA comment letters issued on April 19, 2006, July 13, 2006, November 30, 2006, March 1, 2007 and May 29, 2007. Conditional approval of the August 6, 2007 revision of the Phase II CMS Report was issued by the USEPA in a letter dated January 22, 2008.

1.3.5 Corrective Measures Design

This Corrective Measures Design (CMD) is being submitted to convey the design and construction elements of the Corrective Measures alternatives selected by the USEPA from the Phase II CMS Report and published in the Statement of Basis (USEPA June 2008). As agreed to by USEPA, IDEM and RMC, the CMD approach deviates from both the highly structured approach specified in the Consent Decree, and the single submission format specified in the Final Decision Document. It is believed that the agreed upon approach will both allow for regulatory input during the design process, while expediting the design schedule. The Preliminary Design representing approximately a 20 to 30% level of completion was submitted to USEPA and IDEM on January 8, 2010. Comments on the Preliminary CMD were received in written format in a letter dated February 25, 2010. The USEPA determined that based on the limited scope of comments on the Preliminary CMD that an "on-board" review meeting was not necessary prior to Pre-Final CMD preparation. On April 12, 2010, a Pre-Final CMD was submitted to the USEPA and IDEM. The Pre-Final CMD represented an approximately 90% level of completion. On June 10, 2010, the USEPA and IDEM issued comments regarding the Pre-Final CMD. This Final CMD reflects EPA and IDEM's comments regarding the Pre-Final CMD.

It should also be noted that pursuant to discussions between USEPA, IDEM and RMC it was agreed to include Closure of the Interim Status Hazardous Waste Management Units (Indoor Waste Piles, Outdoor Waste Piles and Surface Impoundment) as a component of the CMD. Inclusions of the Closure activities within the CMD allows the design efforts for both proposed remediation activities to proceed in parallel and provides USEPA relevant information regarding the Closure activities, and IDEM relevant information regarding the Corrective Measures. Additional information regarding the interrelationship between the USEPA and IDEM and the Corrective Measures and Closure is provided in Section 3.0.

1.4 ORGANIZATION

This Preliminary design report is organized as follows:

- Section 1.0 - Introduction (provided above);
- Section 2.0 - Facility Background, including operating history and regulatory status;
- Section 3.0 – Regulatory Purview;
- Section 4.0 – Nature and Extent of Contamination;
- Section 5.0 – Statement of Basis;

- Section 6.0 – Design Elements;
- Section 7.0 – Permitting Requirements;
- Section 8.0 – Public Relations;
- Section 9.0 – Schedule and Cost Estimate;
- Section 10.0 - Post Corrective Measures Storm Water Management; and,
- Section 11.0 – Post Closure Inspection and Maintenance.

2.0 FACILITY BACKGROUND

2.1 FACILITY LOCATION

The RMC facility is located at 3700 South Arlington Avenue in Beech Grove, Marion County, Indiana, and approximately four miles south-southeast of downtown Indianapolis. The Site occupies approximately 24 acres, of which approximately 10 acres represented the active manufacturing area (including paved areas and buildings). The remaining 14 acres include grass and wooded areas. The configuration of the Site is triangular, bounded by South Arlington Avenue (oriented in a north to south direction representing the hypotenuse), Big Four Road (along the base), and the common property line with a natural gas company (Citizens Gas) forming the third side. The northwest end of the triangle is truncated by a railroad right-of-way as depicted on Sheet 1 of the design drawings.

The Site is relatively flat with less than 10 feet of total relief. Natural site drainage is toward the north and east. The former manufacturing area included nearly 80,000 square feet (sf) of structures including the battery breaker, a wastewater treatment plant, a filter press, material storage building, a furnace room, metals refining area warehouse, a vehicle maintenance structure and offices. As indicated in Section 1.2, all of the structures were decontaminated and demolished to grade between August 2009 and January 2010, except the pump houses which were decontaminated but remain to manage storm water. Decontamination and demolition activities were performed in accordance with the *Draft Decontamination and Demolition Plan* (Advanced GeoServices March 4, 2009) and the *Decontamination and Demolition Implementation Plan* (Focus Contracting, June 8, 2009) both of which were submitted, reviewed and approved by the USEPA and IDEM. Summary information regarding the decontamination and demolition activities will be included as an attachment to the Corrective Measures Completion Report to be provided following completion of the Corrective Measures. As stated in Section 1.2, the summary report will include descriptions of the decontamination procedures, waste streams produced and final disposition of the materials sent off-site for disposal or recycling.

The floor slabs, foundations and site paving remain in-place. Debris resulting from the demolition activities was sent off-site for recycling or disposal, except for non-hazardous masonry rubble that was placed under a geomembrane cover within the footprints of the former battery breaker and material storage buildings to prevent infiltration of stormwater, create positive drainage and prevent the ponding of surface water. The paved surface areas drain toward catch basins situated around the Site. The catch basins in-turn, flow to the storm water pump houses. Originally, the storm water from the former manufacturing areas of the Site was discharged to the POTW by the pump houses. Since IDEM approval of a "No Exposure Certification for Exclusion from NPDES Storm Water Permitting" in May 2010, RMC has discharged storm water to the drainage ditch at the north end of the property using the pump houses. The existing pump houses and collection system (inlets and piping) will be demolished and the site regraded to gravity drain storm water as part of the corrective measures and HWMU closure site restoration activities. Demolished components will be salvaged (pumps and controls), recycled, and or disposed in the containment cell.

2.2 OWNERSHIP HISTORY

The Site was reportedly undeveloped woodlands until 1968. In 1968, the property was developed as a secondary lead smelter by National Lead. National Lead operated the facility from 1968 through 1980, when it was sold to Exide Corporation. In 1985, the Site was purchased from Exide Corporation by RMC. RMC continued to operate the facility until the cessation of operations on December 31, 1995. From April 14, 1995 through December 31, 1995, operations were reduced to enriching and casting lead ingots from off-specification lead products. Since 1996, no production has taken place at the facility and operations have been limited to operation of the wastewater treatment facility which was used to manage storm water runoff from the former manufacturing areas prior to 2009 demolition activities.

2.3 REGULATORY HISTORY

As stated above, following the promulgation of RCRA, the facility submitted a Part A RCRA permit application. On November 19, 1980 the facility was granted Interim Status as a hazardous waste treatment, storage and disposal facility. The RCRA Subtitle C units included indoor and outdoor waste piles (used to store batteries and lead-bearing wastes), and the 750,000-gallon concrete lined lagoon. A Part B application was submitted during the mid-1980s, although full RCRA permitted status was never granted. The EPA maintains that interim status was lost on November 8, 1985 as a result of RMC's alleged failure to comply with Section 3005(e)(2) of RCRA, 42 U.S.C. 6925(e)(2); RMC did not agree with this allegation.

RMC submitted a revised Part A application on October 26, 1988 requesting an increase in the storage volume for spent batteries. The request was granted on September 20, 1989. A subsequent revised Part A application was submitted to IDEM on December 7, 1990 for an additional increase in the storage volume of spent batteries, but IDEM denied the increase. RMC filed for a stay and was granted interim status. IDEM approved the revised Part A application on June 3, 1991 with the provision that it did not grant interim status under RCRA. The Part B application was not resubmitted. In 1994, the facility withdrew its Part A and Part B permit applications.

A site inspection was performed under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980. In 1985, a preliminary assessment was performed under CERCLA. No further action was planned under CERCLA at that time.

3.0 REGULATORY PURVIEW

3.1 SEPARATION OF RESPONSIBILITIES

As stated above, the Consent Decree includes the United States Environmental Protection Agency (USEPA) and the Indiana Department of Environmental Management (IDEM) as regulatory participants. Section VI Paragraph 37 of the Consent Decree (Compliance Requirements for Closure) places responsibility for oversight of closure of the interim status hazardous waste management units (indoor waste piles, outdoor waste piles and surface impoundment (lagoon)) under IDEM. Oversight of work in all other areas is the responsibility of the USEPA. This has resulted in parallel investigation activities and slightly different remediation requirements, with the IDEM responsible for "Closure" of those portions of the RMC property contained within the footprint of the HWMUs and USEPA responsible for "Corrective Measures" of remaining on-site areas and all off-site areas.

3.2 HWMU CLOSURE

Irrespective of the slightly different remediation requirements, this Corrective Measures Design has been developed to include remediation required to affect Closure of the HWMUs. Closure activities specific to the HWMUs are presented separately in Section 6.4 of this Design Report and limits of soil remediation are depicted on Sheet 6 of the design drawings. HWMUs are being remediated to attain Closure to the default Industrial Closure Levels for soil, and groundwater at the lagoon, as established under the IDEM RISC Technical Guidance (Last Revised May 1, 2009) except for arsenic and lead in soil where alternate values will be utilized.

Results of soil sampling conducted within the footprints of the HWMUs are provided on Sheet 3 of the design drawings. Groundwater monitoring for the lagoon has been performed pursuant to the requirements of a Groundwater Monitoring Plan approved by IDEM (AGC, June 8, 2007). A discussion of the results of this groundwater sampling and groundwater sampling conducted in conjunction with the RFI is provided in Section 4.5 of the CMD.

3.3 CORRECTIVE MEASURES

The Corrective Measures activities related to soils and sediment to be completed under the purview of the USEPA are being performed specifically for lead. Within the off-site areas readily accessible by the general public, the remediation level for soil and sediment is 400 mg/kg total lead. On-site, soil remediation will be performed to achieve an area wide Preliminary Remediation Goal of 920 mg/kg. For site wide groundwater, the standards will be 0.010 mg/L for arsenic and 0.042 mg/L for lead, the same values to be applied to groundwater for Closure of the lagoon. The site wide groundwater values were previously identified in the Phase II CMS Report as approved by USEPA.

The Final Decision issued by the USEPA determined that a commercial/industrial cleanup standard applies to the neighboring Citizens Gas property and agreed with RMC's interpretation that except for a drainage ditch along the north side of the Citizens Gas property and soil remediation outside the security fence parallel to Big Four Road, no remediation is required on that property and placement of a deed restriction is the only action required as part of the Corrective Measures. RMC has been in discussions with representatives of Citizens Gas for the purpose of negotiating the language and implementation of the deed restriction. Although not required as part of the Corrective Measures, Citizens Gas has requested and RMC has agreed to perform a limited amount of surface soil remediation in conjunction with granting the deed restriction. RMC is planning to perform the surface soil remediation during the Corrective

Measures and HWMU Closure activities. Remediated soils from the Citizens Gas property will be consolidated in the containment cell.

Results of soil sampling conducted off-site are provided on Sheet 3 of the design drawings. A discussion of the results of the groundwater sampling conducted in conjunction with the RFI is provided in Section 4.5 of the CMD and is provided in Tables 1A through 1L. Sampling and evaluation of data being performed in relation to the Monitored Natural Attenuation (MNA) of lead and arsenic in groundwater are considered components of the RCRA Corrective Measure as they have been specified by the USEPA (rather than by IDEM as part of the HWMU closure), and are described in detail in the MNA Work Plan provided as Attachment H.

4.0 NATURE AND EXTENT OF CONTAMINATION

4.1 CONSTITUENTS OF CONCERN IN SOIL AND SEDIMENT

4.1.1 RCRA Facility Investigation

Environmental sampling, performed as part of the Phase I RCRA Facility Investigation (RFI) (sample locations RSB-01 through RSB-85) included sampling for arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver. While the results of the Phase I RFI sampling detected the presence of barium, cadmium, chromium, mercury, selenium and silver, with only some exceptions; concentrations of these parameters were consistently below the Region 9 Preliminary Remediation Goals (PRGs) used for screening results of the Phase 1 RFI sampling in the corrective action areas (i.e., areas outside the boundaries of the HWMUs). Therefore, only lead and arsenic were retained as constituents of concern in soil and sediment in corrective action areas. The Baseline Human Health Risk Assessment (BHHRA), performed as part of the Phase II RFI and revised during the CMS, focused exclusively on lead and arsenic. A detailed summary of the investigation activities and results are provided in the Phase I and Phase II (Revision 1.0) RCRA Facility Investigation Reports (Advanced GeoServices August 31, 2000 and November 18, 2002, respectively) and relevant addenda and response to comments. The final BHHRA is provided as an appendix to the Phase II CMS Report.

4.1.2 Closure Investigation

In addition to lead and arsenic, soil sampling performed as part of the Closure Investigation for the interim status Hazardous Waste Management Units (HWMU) indicated that antimony, cadmium and selenium are present in soil immediately beneath the HWMUs in some sample locations at levels exceeding the IDEM RISC Technical Guidance default values for soil. Therefore, antimony, cadmium and selenium are considered constituents of concern, in addition to lead and arsenic within the HWMUs. Results of the Closure Investigation are presented in the Comprehensive Closure Investigation Report (Revision 1.0) (Advanced GeoServices March 27, 2007) and supplemental data submitted in January, 2008.

4.2 BEHAVIOR OF LEAD AND RELATED CONSTITUENTS

A number of the materials formerly used at the facility have toxic characteristics; however, the principal material of concern is lead. Lead is a common metal, and can be found at an average concentration in excess of 30 ppm in natural soils and 1-10 ug/l in surface water. Most lead salts are fairly insoluble in water; however, the solubility depends on the pH, with solubility increasing in more acidic conditions. Movement of lead in soils depends on its adsorption, chelation with organic matter, and the precipitation of the less soluble salts. In general, lead reacts with soil anions or clays to form insoluble complexes, inhibiting its mobility. Lead can be ingested or absorbed by inhalation. Poisoning from acute exposure to lead is uncommon. The primary toxic effects from chronic exposure are on the blood and the nervous system. Antimony, arsenic, cadmium and selenium are all considered insoluble inorganic constituents and their behavior is generally similar to the behavior lead. The only notable difference is that arsenic is naturally occurring in regional soils at levels that have been noted to exceed the IDEM RISC Technical Guidance default values and arsenic is relatively more soluble than lead.

4.3 DISCUSSION OF SOURCE AREAS

Based on the documented operating history of the facility, results of the Closure and RFI sampling activities, and an understanding of the character of the mobility and transport of lead and arsenic, the most significant potential sources of contamination impacting surface and shallow subsurface soils at the facility during its operating history were erosion and transport of lead-bearing solids; fugitive dust; and filling performed using impacted soils or slag resulting from the furnace operations. Sampling activities were designed to target the areas of impact from each of the potential sources. Soil and sediment sample locations are depicted on Sheet 2 and the results of the sampling are provided on Sheet 3. A supplemental qualitative discussion regarding the sampling results is provided below.

4.4 EXTENT OF IMPACT

4.4.1 Drainage Ditches

Erosion and transport of lead bearing solids from sources, such as the outdoor waste piles or materials tracked from operating areas of the facility may have occurred before the facility was upgraded to capture and treat storm water falling in the active manufacturing areas of the facility. The impacts associated with the erosion and transport of lead impacted solids would be manifested in the form of elevated concentrations within drainage paths leading from the facility. Sampling was conducted in the drainage ditches along the railroad spur and tracks north of the former manufacturing area ("northern drainage ditch"), along the north side of the main driveway, and along South Arlington Avenue. The sampling focused on the centerline of the drainage ditches and identified soil/sediment impacted by lead in excess of 400 mg/kg. In the northern drainage ditch, lead exceeded 400 mg/kg to a distance of approximately 600 feet west of the northwest corner of the RMC property; in the driveway drainage ditch, lead exceeded 400 mg/kg along the entire length; and along South Arlington Avenue, lead exceeded 400 mg/kg from approximately 1,000 feet north to 1,000 feet south of the main driveway.

4.4.2 Surface Soil

Fugitive dust emissions are generated by traffic, wind and similar sources that cause dust on the ground surface, exposed waste materials and/or materials from production areas to become suspended in air and transported. Generally the particulate size of fugitive dust is large and as a result, the area impacted by the fugitive dust is relatively limited. Sampling determined that fugitive dust has caused some impacts to the surface soils on the adjacent Citizens Gas property west of the facility manufacturing area. Impacts from fugitive dust were not identified in off-site areas north, south and east of the facility, where the property boundaries are typically 200 feet or greater from the former manufacturing area.

A BHHRA was conducted for an exposure scenario intended to replicate workers at the Citizens Gas facility, the results of which were included in the Phase II CMS Report. The BHHRA evaluated the potential for the receptor to have adverse impacts from arsenic (using the 95% UCL) and lead (using the mean lead). The results of the risk assessment for arsenic determined that the total excess lifetime cancer risk on the Citizens Gas property is 8x10-6, with a Total Hazard Index of 0.05, which did not represent an unacceptable risk. The lead risk assessment predicted a 95th percentile fetal blood lead level (BLL) of 7.4 ug/dL, which is below the allowable maximum of 10 ug/dL. Through the BHHRA is was determined that lead and arsenic did not represent an unacceptable risk for the non-residential exposure scenarios evaluated on the Citizens Gas property and, therefore; remediation was not required as part of the Corrective Measures. As required by the Final Decision, RMC and Citizens Gas have been negotiating a deed restriction against future residential development of the property. Citizens Gas has agreed to record the required deed restriction if RMC performs remediation of a limited amount of surface soils. RMC has agreed to perform the remediation requested by Citizens Gas. RMC is planning to perform the surface soil remediation on the Citizens Gas property during the Corrective Measures and HWMU Closure activities and to consolidate the remediated soils in the containment cell.

4.4.3 Subsurface Soil

During the early operating history of the facility, feed materials destined for recycling and waste products resulting from the recycling process (i.e. slag) were managed on the unpaved exterior surfaces. As a result, shallow subsurface soils have become intermixed with materials containing high concentrations of lead. In addition, various modifications and expansions of the manufacturing area were conducted periodically that required minor amounts of grading. The results of these activities are elevated concentrations of COCs in the shallow subsurface soils. In most areas the depth of impact is less than 12-inches, with a few areas extending up to 36-inches. The only areas deeper than 36-inches are within the HWMU along the northern limits of the manufacturing area where areas of filling and disturbance are as much as 8-feet below existing ground surface. It was also determined that an area within the material storage building HWMU had impacted soil requiring remediation as deep as 6-feet.

4.4.4 Storm Water Lagoon

The storm water lagoon is an interim status HWMU. Sampling was conducted to characterize the nature of sediments within the lagoon and the impact of the lagoon on underlying soils. The results of the sediment sampling (CSED-1 through 4) in the lagoon identified concentrations of antimony, arsenic, cadmium and lead above the IDEM RISC industrial soil default values. The sediment is typically 6-12 inches in thickness and overgrown by cattails. The lagoon is lined by a geomembrane in poor condition and concrete. Sampling conducted during the initial investigation activities included the collection of soil samples from beneath the liner system (CSB-43 through 47). The results of that sampling identified one sample with an arsenic concentration slightly above the proposed cleanup level. It should also be noted that samples of storm water collected from the lagoon during and after decontamination and demolition activities did not exceed the discharge limits established by the temporary discharge permit and were included as part of the results that formed the basis for IDEM authorization for surface discharge of storm water.

4.5 GROUNDWATER IMPACTS

Groundwater conditions have been evaluated through the installation and sampling of twelve (12) shallow and two (2) deep monitoring wells. Monitoring well locations are shown on Figure 3. Groundwater in the shallow zone of saturation near the former manufacturing area occurs as perched zones within thin, laterally discontinuous layers of sand and sandy silts contained in clayey-silt and silty-clay glacial deposits. The monitoring wells identified as "deep" are screened within a middle perched zone located 75 to 85 feet below ground surface. "Depth to water" measurements indicate that the potentiometric surface of the middle perched zone is on the order of 14 to 17 feet below ground surface, while the shallow perched zone is typically less than 5 feet below the ground surface.

The results of groundwater sampling conducted as part of the RFI, Closure Investigation and CMS are provided in Tabular format on Tables 1A through 1L. The results for arsenic and lead are screened against the IDEM Industrial Default RISC Criteria 10 ug/L and 42 ug/L, respectively. (The 10 ug/L value for arsenic is the same as the MCL for arsenic). The remaining constituents are screened against the MCLs. A groundwater contour map is provided for the (January 2007) site wide sampling event on Figure 3. Total results for lead and arsenic from the January 2007 groundwater sampling event for the shallow groundwater wells are also presented on Figure 3.

A review of shallow groundwater sample results, obtained as part of the RFI and Closure activities (Tables 1A through 1L), shows that the current MCL for arsenic (10 ug/L) has been exceeded on more than one occasion at groundwater monitoring wells MW-1, MW-2, MW-3, MW-7, MW-8 and MW-10. The 42 ug/L IDEM Industrial Default RISC Criteria for lead is exceeded in unfiltered samples on more than one occasion in MW-2 and MW-7. With the exception of MW-3, each of the wells that exceed the IDEM Industrial Default RISC Criteria for arsenic or lead is located within or immediately adjacent to an area of the Site identified to contain some of the most deeply impacted soils.

MW-3 has had two total arsenic results at 11 ug/L, one total arsenic result at 28 ug/L and a result of 170 ug/L. The available filtered results for MW-3 have all been below 10 ug/L and field logs from the sampling event corresponding to the 170 ug/L (January 2007) result indicate that the turbidity of the sample was so high that the turbidity probe indicated an erroneous reading. Field parameters for all wells are also provided in Tables 1A through 1L. Recognizing that MW-3 was constructed in 1990, that the site soils have a naturally high arsenic content and that MW-3 is located in an area of the Site not associated with the recycling and smelting operations, the arsenic exceedances observed in MW-3 are believed to be a reflection of turbidity in the well and not water quality.

Although results of the groundwater sampling did not reveal site wide groundwater impacts, results did detect arsenic and lead above screening levels utilized for this project. Therefore, USEPA has requested that shallow groundwater be included as a component of the Corrective Measures for the site. The Constituents of Concern for groundwater are lead and arsenic. The selected remedy for groundwater is monitored natural attenuation (MNA). Section 5.5.2 and Attachment H provide a description of the groundwater sampling to be performed as part of the MNA.

5.0 STATEMENT OF BASIS

5.1 GENERAL

The results of soil and sediment sampling conducted as part of the RFI and site specific risk assessment performed during the CMS have determined that lead is present in soil and sediment on the site at concentrations that could represent an unacceptable risk to future occupants and therefore; require corrective measures. The RFI sampling conducted in off-site areas identified concentrations of lead in surface soil and sediment greater than the USEPA Regional Screening Level (RSL) for residential exposure to lead in soil and although a site specific risk assessment did not indicate a currently unacceptable risk within these areas, RMC has agreed to the USEPA's request to also perform corrective measures. Soil sampling performed as part of the Closure investigation also identified concentrations of lead and associated inorganic compounds in shallow subsurface soils beneath the pavement and floor slabs of the former indoor and outdoor waste piles. RMC must also close the storm water lagoon.

5.2 CORRECTIVE MEASURES

As stated above, the entire Site, except for those portions within the footprint of the HWMUs, is under the regulatory purview of the USEPA and was the subject of a Corrective Measures Study (CMS). The CMS included a human health risk assessment that evaluated specific non-residential exposure scenarios for the Site and proposed remediation alternatives for review and consideration by the USEPA. The Corrective Measures alternatives selected in the Statement of Basis issued by the USEPA are the excavation of soil above a Remedial Action Level (RAL) calculated to achieve an exposure area wide Preliminary Remediation Goal (PRG) and consolidation of the remediated soil in an on-site containment cell.

The soil PRG calculated by the risk assessment for the Site is 920 mg/kg. The risk assessment evaluated the Site as "Grassy" and "On-Site" exposure areas (Figure 2) and using the results of RFI and Closure sampling calculated RALs as follows:

- 4,954 mg/kg total lead in "grassy" areas; and,
- 8,470 mg/kg total lead in paved areas.

A deed restriction against future residential or other development inconsistent with the risk assessment exposure assumptions will be filed with the Site deed.

For soil and sediment in off-site areas accessible to the general public, RMC has agreed to perform excavation activities to a remediation level of 400 mg/kg total lead. Attainment of the proposed remediation concentrations will be based on post excavation sampling. The protocol for performing the sampling and interpreting the results is provided in the CQAP (Attachment D).

5.3 HWMU CLOSURE

The HWMU areas are RCRA Subtitle C Interim Status units. As stipulated in the Consent Decree, the HWMU areas are being closed under the regulatory purview of IDEM. RMC is proposing to perform the closure activities concurrent with the Corrective Measures and will be consolidating the remediated soils and sediment into the proposed on-site containment cell.

As documented in Advanced GeoServices Corporation's (AGC) September 24, 2008 letter to IDEM, it is RMC's intention to "clean close" the HWMUs. Based on the IDEM RISC Technical Guidance Industrial Default Closure Values, the target closure concentrations ("Standards") to be applied for the HWMUs are summarized as follows:

Parameter	Soil Standard	Groundwater Standard
Antimony	37 mg/kg	NA
Arsenic	20 mg/kg*	0.010 mg/L
Cadmium	77 mg/kg	NA
Lead	970 mg/kg**	0.042 mg/L
Selenium	53 mg/kg	NA

Notes:

*** The Soil Standard proposed for arsenic represents the "Direct Soil" value contained in RISC Industrial Closure Levels Table A (IDEM May 1, 2009). This value will be utilized over the default value of 5.8 mg/kg (based on Migration to Groundwater). Justification for use of the alternate value based on soil sampling which demonstrated a background arsenic concentration of 12.7 mg/kg and site specific SPLP testing which demonstrates an average partitioning coefficient more than an order of magnitude greater than the portioning coefficient utilized to calculate the default Migration to Groundwater value. This represents a modification of the value for arsenic proposed in the September 24, 2008 letter to IDEM.**

**** The Soil Standard proposed for lead represents the "Construction" value contained in RISC Industrial Closure Levels Table A (IDEM May 1, 2009). This value will be utilized over the default value of 230 mg/kg (based on Migration to Groundwater). Justification for use of the alternate value is based on site specific SPLP testing which demonstrates an average partitioning coefficient more than an order of magnitude greater than the portioning coefficient utilized to calculate the default Migration to Groundwater value.**

Standards are not shown for barium, chromium, mercury or silver, as these parameters were not indentified during Closure sampling at concentrations greater than the default Industrial Closure Levels for soil or groundwater, as established under the IDEM RISC Technical Guidance (Last Revised May 1, 2009). Standards for antimony, cadmium and selenium are limited to values for soil only as none of these constituents was detected at concentrations above the their respective default Industrial Closure Levels for groundwater, as established under the IDEM RISC Technical Guidance (Last Revised May 1, 2009).

Attainment of the proposed closure levels within the HWMUs will be based on post excavation sampling. The protocol for performing the sampling and interpreting the results will be based on procedures contained in the IDEM RISC Technical Guidance for default closure sampling (RISC Technical Guidance Section 6.3). The target potential exposure concentration (PEC) for the bottom of the excavations will be 970 mg/kg total lead. Specific information regarding the closure sampling are provided in the CQAP (Attachment D), but in general the intent is to demonstrate that the mean for the samples (collected randomly) representing a specific closure area is at or below the PEC.

5.4 CONTAINMENT CELL

Pursuant to the Statement of Basis issued by the USEPA, the containment cell will be situated in the northwest corner of the Site. The containment cell will be defined by a perimeter soil berm, have a soil bottom and be capped with a composite cap system. The composite cap will consist of (from top to bottom) a vegetative cover, erosion control mat, 6-inches of topsoil, 18 inches of compacted soil, double sided composite drainage net, 60 mil textured geomembrane and non-woven geotextile placed on a smooth, compacted soil subgrade. The drainage net will terminate in an anchor trench constructed in the perimeter soil berm. The anchor trench will contain a perforated pipe in a stone annulus designed to drain water from the drainage net to the surrounding ground surface.

Cover soil sliding and interface stability calculations have been performed and are provided in Attachment C. Those calculations have been performed for the "worst-case" slope condition based on the maximum cell grading (β = 33%, H=16 ft and L=48 ft) and an assumed minimum interface friction angles and soil unit weight (Φ=22° and σ =120 lb/ft^3). Collectively these values provide an interface factor of safety of 1.22. These are assumed values and must not be relied upon for final stability. As described in Specification Section 02751, interface friction testing ("shear box testing") must be performed utilizing the actual geosynthetic liner materials and cover soil fill proposed for use by the Contractor for cap construction. The shear box testing will be performed at confining pressures of 0.5, 1.5 and 3.0 psi for each interface (cover soil to geocomposite; geocomposite to textured geomembrane; textured geomembrane to geotextile; and geotextile to sub soil) and the result utilized to estimate the residual friction angles for each interface. If the results are less than 22°, the factor of safety will be less that 1.2 and the interface will be considered "unstable". If an unstable interface exists, RMC will have the option of requiring the Contractor to perform testing of alternate materials until acceptable interface friction values are achieved or modifying finished grading of the containment cell to attain the minimum required factor of safety.

As a result of the change in the containment cell location required by the Statement of Basis, sufficient space is available to allow an increase in the size of the cell foot print from approximately 1.15 acres to 1.44 acres (as measured at the anchor trench). At the maximum 3:1 grading shown on Sheet 5, cell capacity will be approximately 25,679 cubic yards; sufficient volume to accommodate all of the soil and sediment currently proposed for remediation as part of the Corrective Measures and HWMU Closure and still provide additional excess capacity for soils from the Citizens Gas property and/or additional material generated on-site as a result of additional excavation performed within area of failing confirmatory sampling results. In the event the additional airspace it not required, the larger footprint will allow the finished containment cell to have a lower profile cap than the maximum configuration shown on Sheet 5. If insufficient air space is available to accommodate all remediated soil and sediment, excess materials will be sent for off-site disposal. Sheet 5 also shows the completed cap with the minimum required finished cap slope of 3%. The associated volume for the minimum grading is <6,000 cy.

5.5 GROUNDWATER

Groundwater sampling conducted as part of the RFI has identified concentrations of arsenic in the shallow perched groundwater above 10 ug/L on more than one occasion in MW-1, MW-2, MW-3, MW-7, MW-8 and MW-10; and lead concentrations above 42 ug/L on more than one occasion in MW-2, and MW-7. The Statement of Basis issued by the USEPA, requires RMC place a deed restriction on the property against the use of groundwater from the Site as a potable water source. The Statement of Basis also selected Monitored Natural Attenuation (MNA) as the approach to restoring groundwater quality. MNA is predicated on an improvement of groundwater quality following completion of the proposed soil remediation activities. In addition, RMC must install and sample a system of groundwater monitoring wells capable of monitoring groundwater quality in the vicinity of the containment cell for indications of groundwater degradation.

5.5.1 Containment Cell Groundwater Monitoring

During the initial stages of Corrective Measures implementation, RMC will have groundwater monitoring wells MW-7 and MW-10 and the former facility production well abandoned. Permanent abandonment shall be in accordance with the requirements established in 312 Indiana Administrative Code 13-10 (Rule 10). Rule 10 requires that abandonment activities be performed by a water well driller using a neat cement, bentonite slurry, or crushed or pelletized bentonite. Notification of abandonment will be filed by the well driller within 30 days following completion of plugging activities.

Immediately following construction of the containment cell perimeter access road, RMC will install six new shallow wells to monitor groundwater quality in the shallow perched zone beneath and in the general vicinity of the proposed containment cell. The proposed well locations, labeled as CC-1 through CC-6, are identified on Sheet 4 of the design drawings. The well locations were selected to encompass the Containment Cell to monitor groundwater quality for indications of groundwater degradation. The new wells and remaining existing wells will be surveyed by a professional surveyor retained by RMC to ensure all groundwater measurements are utilizing the same vertical and horizontal datum. The containment cell monitoring wells (CC-1 through CC-6 and MW-2) will be subject to at least one round of groundwater sampling prior to and/or coincident with corrective measures construction and then routine monitoring following completion of corrective measures construction as part of long term Operation and Maintenance activities.

5.5.2 MNA Groundwater Monitoring

The area of site groundwater that is the subject of MNA was determined based on the results of previous groundwater sampling, the hydrogeologic conceptual site model, and an understanding of the operating history of the facility. The groundwater monitoring wells to be included as part of the MNA groundwater monitoring network will consist of MW-1, MW-2, MW-3, MW-8, MW-9, MW-12, and CC-1 through CC-6. These wells have been selected as they bound the MNA monitoring zone. Existing wells MW-7 and MW-10 are not included as part of the proposed MNA sampling network because they are located in the prepared containment cell location and are proposed for abandonment as part of the proposed corrective measures. As summarized in Section 4, groundwater sampling has identified concentrations of arsenic > 10 ug/L in MW-1, MW-2, MW-3, MW-7, MW-8 and MW-10; and concentrations of lead >42 ug/L in MW-2 and 7. Pursuant to the Statement of Basis, RMC will conduct sampling at the designated wells for the purpose of determining if concentrations are increasing, decreasing or stable, and to collect data regarding groundwater parameters that directly impact groundwater geochemistry.

The MNA groundwater monitoring wells will be sampled beginning approximately one month following installation of the proposed containment cell monitoring wells. Sampling will be performed once every calendar quarter for twelve consecutive quarters with the first evaluation regarding future frequency performed after completion of the second year of monitoring (i.e., after 8 quarters). Monitoring will end when the sampling results demonstrate that the remedial goals have been attained for four consecutive quarters. During the first two quarterly groundwater sampling events, samples will be analyzed for total and dissolved arsenic and lead, sulfide, sulfate, nitrate arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), and manganese speciation (MnII/MnVII) for use in geochemical modeling. Beginning after the second quarterly groundwater sampling event, groundwater analysis will be limited to total and dissolved lead and arsenic. Field parameter readings to be recorded at the time of sample collection during all groundwater sampling events shall include temperature; pH; Eh; dissolved oxygen (DO); specific conductance and turbidity.

Detailed information regarding the proposed MNA activities is provided in the MNA Work Plan (Attachment H).

6.0 DESIGN ELEMENTS

6.1 PREPLANNING, PERMITTING, AND ACCESS

The selected Contractor will be required to provide a detailed construction schedule presenting his proposed approach to the project. The schedule, with appropriate backup information, will reflect the Contractor's approach to the project including the anticipated sequence of construction, estimated times for completion, assumed production rates, critical path and milestones. The schedule will also demonstrate their understanding of intrinsic design elements. The construction schedule will not be subject to regulatory approval, except to the extent the Contractor's approach or sequence may significantly deviate from the CMD as currently proposed. Acceptance of the schedule by RMC will not be considered approval of a variance from the CMD or other requirements of the Contract unless specifically approved in writing by RMC. Copies of the schedule will be provided to the USEPA and IDEM prior to the start of work.

A pre-construction meeting between representatives from RMC, the Contractor, owners of property which will be remediated, and the appropriate Agencies will be held at the Site prior to the onset of active remedial activities. During the pre-construction meeting, the Contractor will present his approach to the project including schedule and sequence of work and address questions and concerns.

Remedial activities will not begin until the necessary permits are granted and required Notice of Intent (NOI) letters (erosion and sediment control) have been submitted to and approved by IDEM. A list of the required permits has been identified and is included in Section 7.0.

Access to off-site areas requiring remediation will be secured prior to the onset of corrective measures. Amtrak and CSX were contacted during preparation of the Pre-Final Design to determine limitations and restriction associated with excavation or construction activity within railroad right-of-ways and to discuss any additional considerations regarding work in close proximity to their tracks. Through those contacts, it was confirmed that CSX is the owner of the right-of-way for the tracks north of the site and Citizens Gas; however; information received from Amtrak indicates that they do not own the tracks between Big Four Road and the Citizens Gas fence. A review of the Marion County Indiana Tax Assessors office determined that the property between the southern fence for Citizens' Gas and Big Four Road is owned by Citizens Gas.

Relative to work in the CSX right-of-way, RMC is providing additional design details for their review. The proposed excavation is a minimum of 25 feet from the closest rail and the depth of proposed removal are outside the "theoretical railroad embankment line" (a 1:1.5 line that extends out and down from a point located 12 feet from the centerline of the track) that would require sheeting and shoring. Requirements for the access by equipment and personnel between the tracks and proposed excavation will also require that the Contractor carry specific railroad insurance and have a CSX approved flagman present during the work to control access and train traffic. To protect the track on the property owned by Citizens Gas, no excavation will be performed within the theoretical railroad embankment line. The theoretical railroad embankment line has been plotted on excavation cross-sections provided on Sheet 12.

Work within the right-of-way of South Arlington Avenue will require that the Contractor obtain a right-of-way permit. Typically these would be issued through the City of Beech Grove but because South Arlington Avenue is identified as a "primary arterial road" additional approval from the City of Indianapolis may be necessary.

6.2 SITE PREPARATION, DUST CONTROL AND STORM WATER MANAGEMENT DURING CONSTRUCTION

Site preparation activities will include establishment of the support zone, installation of erosion control measures, implementation of dust control measures and air monitoring, mobilization and activation of temporary water treatment equipment and utility location and abandonment, as needed. Exclusion and contaminate reduction zones will be designated to mitigate cross contamination. Equipment and personnel decontamination stations will be instituted to minimize the potential of contaminant release. Traffic routes and access will be established for transport of contaminated materials between excavation areas and the containment cell.

Clearing and grubbing of the containment cell location and other excavation areas within the northern wooded area will be required to facilitate equipment access. Roadways will need to be established for material transport. These areas will require grading such that erosion and sediment control is maintained.

Dust control measures will be selected by the Contractor based on the means and methods proposed for completion of the project. In general, these are expected to include the use of water to wet the ground surface and areas of excavation. During decontamination and demolition activities the contractor mobilized large spray-misters that utilized fans and water spray to wet the work zone in the surrounding area and to help suppress dust. The contractor also utilized a water truck on a nearly continuous basis during dry weather to keep site pavement wet. Section 02115 of the Specifications provides additional information related to dust control and Section 02999 provides requirements for dust control and air monitoring.

Storm water management and erosion controls will be performed in accordance with applicable standards and practices as set forth in the Indiana Storm Water Quality Manual and the Indianapolis Storm Water Design and Construction Specifications Manual. Storm water during construction activities can be characterized as follows: storm water runoff from areas of exposed soils and sediment requiring remediation (i.e., active excavations) and storm water runoff from areas not designated for remediation or where remediation is already completed (i.e. "clean areas").

Storm water associated with active excavations, and decontamination water, will require collection and treatment prior to discharge to the POTW through the existing sanitary sewer. Collected water requiring treatment at a minimum will be processed through a series of bag filters. The Contractor will determine the exact configuration and filtration requirements necessary to meet the discharge requirements established by the POTW and determine if additional treatment is necessary. Storm water and decontamination water will be treated in batches and stored in tanks until approved for discharge by the Engineer based on analytical results representing the treated batch. To the extent possible, the Contractor will utilize treated water for dust control purposes in an attempt to reduce the volume of water discharged to the POTW. The maximum batch size shall be 30,000 gallons. The maximum discharge rate to the POTW will be 90 gallons per minute or as otherwise dictated under the Special Discharge Permit. The limits for discharge of water to the POTW will be established under the Special Discharge Permit and therefore the exact parameters and values can not be determined at this time. However, for comparison purposes the following parameters and limits were required for the decontamination and demolition activities:

- pH 5.0 to 12.0 S.U.
- Arsenic 4.0 mg/L
- Lead 4.7 mg/L
- Zinc 36.0 mg/L
- TPH 200 mg/L

Storm water from the clean areas will not require collection and management, except to the extent required to control erosion, avoid entry into active excavations and work zones, and prevent uncontrolled runoff to adjacent property. The Contractor will utilize the existing pump and piping system to convey clean storm water runoff from the existing sump areas to the drainage ditch along the CSX right-of-way. The Contractor will sequence his work to ensure the four pump houses will remain in operation as long as possible during construction or he will establish new temporary pumping to continue water management. During excavation and restoration activities in the CSX drainage ditch, the Contractor will be required convey the storm water to a location down stream from the disturbed section of the drainage ditch.

The lagoon will cease to be used for storm water management when closure of the lagoon begins. The current paved surfaces at the Site have been cleaned as part of the decontamination and demolition project and the associated storm water runoff is approved for discharge without treatment. If an area contributing runoff to one of the pump houses or collection area established by the Contractor becomes re-contaminated, the Contractor will be required to analyze the accumulated water from that pump house and demonstrate the water still meets the appropriate discharge criteria. If the water does not meet the discharge criteria the Contractor will be required to collect and treat all storm water flowing to that pump house.

Storm water from the "grassy" areas, will continue to be managed by utilizing existing drainage features such as the perimeter swales. The construction within the grassy areas and swales will be sequenced such that remediation in the upslope areas is completed before down slope areas. This will help prevent recontamination. The design requires restoration of remediated swales using either grass sod or geotextile and stone each of which allows immediate re-stabilization of the remediated areas.

6.3 CONTAINMENT CELL CONSTRUCTION

The containment cell will be situated in the northwest corner of the Site, as shown on Sheet 5 of the design drawings. The containment cell will be 330 feet long by 190 feet wide defined by the centerline of an 8 feet wide earthen berm. The berm will have a top of berm elevation of 843.0 and an interior bottom elevation of 841.5. Perimeter drainage features will convey stormwater runoff to the proposed stormwater management basin.

A review of potentiometric groundwater levels collected at MW-10 since installation in 2003 shows the groundwater elevation within the vicinity of the proposed containment cell have varied between 833.24 (October 2007) and 841.25 (April 2005) standing water has been noted in the vicinity of MW-10 after precipitation events. Based on a direct comparison, this means the groundwater has ranged from 8.26 feet below to 0.25 feet below the proposed cell bottom elevation. Following completion of proposed grading and drainage features, the minimum vertical separation is expected to be at least 1.0 feet based on a maximum possible surface water elevation in the stormwater basin of 840.5. In addition, the impermeable barrier created by the cap essentially eliminates infiltration beneath the cap footprint.

Proposed finished grades will be no steeper than 3 horizontal to 1 vertical (33%) and no flatter than 33 horizontal to 1 vertical (3%). The maximum proposed elevation of the top of cap will be 862.5 +/-. The maximum grading shown on Sheet 5 of the design drawings for the top of waste and top of cap represents the maximum filling configuration and provides a waste disposal capacity of approximately 25,679 cubic yards. The total combined volume of soil, sediment and miscellaneous debris to be excavated is approximately 18,000 cubic yards. This includes approximately 5,000 cy of soil from the HWMUs, approximately 6,000 cy of soil from other on-site areas, approximately 5,000 cy of on-site debris and approximately 2,000 cy of off-site soil and sediment (excluding material from Citizens Gas).

The containment cell berm will be located 50 feet from the northern and western property boundaries as measured from the centerline of the proposed berm. The area between the berm and property line will be utilized to accommodate a perimeter access road and swale. The access road will provide access for sampling the proposed groundwater monitoring wells and maintaining the swale. The swale will collect runoff from the west and north sections of the containment cell cap and convey it into the outlet structure for main storm water management basin. The remainder of the cap and storm water from the majority of the former manufacturing area will drain directly to the storm water management basin located east of the cell. The invert elevation of the lowest outlet device for the basin will be 837.25; during periods of higher groundwater, the basin may also convey some groundwater.

Construction of the cell will require minor cutting and filling to create the swale, berm and access road. Existing groundwater monitoring wells MW-7 and MW-10 will be abandoned by RMC prior to the start of Corrective Measures construction. Permanent abandonment of groundwater monitoring wells MW-7 and MW-10, and permanent abandonment of the former facility production well (located near the former warehouse) shall be in accordance with the requirements established in 312 Indiana Administrative Code 13-10 (Rule 10). Rule 10 requires that abandonment activities be performed by a water well driller using a neat cement, bentonite slurry, or crushed or pelletized bentonite. Notification of abandonment will be filed by the well driller within 30 days following completion of plugging activities.

Existing trees will need to be cleared and grubbed from the proposed containment cell and storm water management basin area. Cleared and grubbed material (trees and shrubs) will be sent off-site for disposal. Excavation areas NW and ND1 will be dug to the vertical and horizontal limits shown on Sheet 7 and the resulting spoils (approximately 1,000 CY) stockpiled to await placement in the containment cell. After completion of remediation in NW and ND1 the topsoil will be stripped from the remaining area and placed in 500 cy (maximum) stockpiles. The volume of topsoil to be stripped is uncertain, but assuming an average thickness of 8-12 inches, is expected to be on the order of 3,000 to 5,000 cy.

After removal of the topsoil, cutting and filling of native soils will be performed to achieve the design grades necessary to define the perimeter access road, swale, containment cell and storm water management basin. No confirmatory sampling is required prior to commencement of cutting and filling except as required within excavation areas NW and ND1. Depending on the average thickness of topsoil removed it may be necessary to import structural soil fill (Specification Section 02210) to complete the required grading. If excess native soils remain after completion of required grading excess materials shall be stockpiled (500 cy max) and characterized to determine the acceptability for use as backfill elsewhere on-site.

General procedures for stockpile sampling are provided in the Sampling and Analysis Plan portion of the Construction Quality Assurance Plan (Attachment D). Stockpile samples will be analyzed for lead, arsenic, antimony, cadmium and selenium (Method 6010). Analytical results for arsenic, antimony, cadmium and selenium will be compared against the soil standards listed for HWMU Closure in Section 5.3 of the CM Design Report. Lead will be compared against the 920 mg/kg PRG calculated by the BHHRA and the 400 mg/kg residential soil screening value being used for lead in soil within the public and railroad right of way. Stockpiles with results below the HWMU soil standards for arsenic, antimony, cadmium and selenium and less than 400 mg/kg lead can be utilized as backfill anywhere on-site. Stockpiles with results below the HWMU soil standards for arsenic, antimony, cadmium and selenium and between 400 mg/kg and 920 mg/kg total lead can be utilized as backfill anywhere on-site except within drainage features and the storm water management basin. Stockpiles with results that exceed the HWMU soil standards for arsenic, antimony, cadmium and selenium or have >920 mg/kg lead will be placed in the containment cell or sent off-site for disposal.

Containment cell filling will be performed in lifts. Lifts will have a maximum loose lift thickness of 18-inches and each lift will be compacted until visually stable as determined by the QA Representative. Filling will be sequenced to contain storm water runoff from the exposed waste surface and the contractor will be required to collect and treat standing water prior to placement of subsequent lifts. Access into the cell will be provided from the south end and equipment entering the cell and running across areas of exposed soil will be required to clean the wheels before exiting the cell. The Contractor is encouraged to utilized designated equipment in the cell and dump materials destined for the cell without actually entering the cell.

6.4 HAZARDOUS WASTE MANAGEMENT UNIT CLOSURE

6.4.1 Surface Impoundment

The surface impoundment (lagoon) is an Interim Status RCRA Hazardous Waste Management Unit (HWMU) that is subject to the Closure requirements contained in 40 CFR 265.228. The Contractor will remove standing water in the lagoon. The Contractor may elect to transfer the water directly to holding tanks for testing or process the water through the temporary water treatment system prior to placement in the tanks and testing. The accumulated sediment and vegetation will be removed and placed in the on-site containment cell. Throughout sediment removal the Contractor will continue to collect and manage water draining from the sediment. After removal of liquid, bulk sediment, vegetation, the liner and miscellaneous debris, the Contractor will demolish the concrete component of the liner. Demolition of the concrete liner will be performed from the perimeter of the lagoon and work inwards taking care to minimize disturbance to the subsoils.

Cement concrete (including masonry) will be crushed to the gradation requirements for Granular Fill specified in Specification Section 02210 or Surface Stone specified in Section 02936, separated into stockpiles (not exceeding 500 cubic yards each) and sampled (see stockpile sampling requirements in the Sampling and Analysis Plan portion of the Construction Quality Assurance Plan (Attachment D)). To determine the acceptability of the material for use as fill the samples will be analyzed for lead, arsenic, antimony, cadmium and selenium (Method 6010). Analytical results for arsenic, antimony, cadmium and selenium will be compared against the soil standards listed for HWMU Closure in Section 5.3 of the CM Design Report. Lead results will be compared against the 920 mg/kg PRG derived by the BHHRA and the 400 mg/kg residential soil screening value being used for lead in soil within the public and railroad right of ways. Crushed concrete and masonry stockpiles with results below the HWMU soil standards for arsenic, antimony, cadmium and selenium and less than 400 mg/kg lead can be utilized as Granular Fill or Surface Stone anywhere on-site. Crushed concrete with results below the HWMU soil standards for arsenic, antimony, cadmium and selenium and between 400 mg/kg and 920 mg/kg total lead can be utilized as Granular Fill anywhere on-site except within the drainage features or the storm water management basin. Stockpiles with results that exceed the HWMU soil standards for arsenic, antimony, cadmium and selenium and/or with >970 mg/kg lead will be placed in the containment cell or sent off-site for disposal. Crushed concrete sent for placement in the containment cell may not be placed within 12-inches of the final top of waste unless crushed to a maximum particle size <1.5 inches.

Previous sampling of soil beneath the concrete liner produced results that were all below the action levels being applied to closure of the HWMUs except for a single sample (CSB-37 A (0-3 inches)) which had an arsenic concentration of 25 mg/kg. This result is only slightly above the action level for arsenic of 20 mg/kg and in consideration of the associated lead result of 58 mg/kg, is believed to be a reflection of variability in background arsenic concentrations rather than impacts from former facility operations. Therefore, no soil remediation is proposed within the footprint of the lagoon. The Engineer will collect soil samples from the soil immediately beneath the concrete following the procedures established in the CQAP for confirmatory sampling at the bottom of excavations. The results will be evaluated as confirmatory samples against the soil standards established for the HWMUs in Section 5.3 of the CM Design Report.

6.4.2 Former Waste Pile Locations

Those areas of the Site horizontally utilized for the management of feed materials for the recycling operation and resulting solid waste materials were designated as waste piles in the facility Part A filing and granted interim status under RCRA. The waste pile areas were subject to focused sampling as part of the Closure Investigation and were also subject to a limited amount of additional sampling as part of the site wide RCRA investigation. The locations and results of the borings are provided on Sheets 2 and 3 of the design drawings, respectively. Additional discussions of the design elements for the former waste piles are provided separately below based on those that were indoors and those that were outdoors.

6.4.2.1 Outdoor Waste Piles

The Outdoor Waste Piles consist of six separate areas (number 1 through 6) as shown on Sheet 1 of the design drawings. The total combined area of the Outdoor Waste Piles is approximately 1.8 acres. Records indicate that the outdoor waste piles were originally utilized to store lead bearing materials waiting processing recycling and waste products (primarily slag) awaiting off-site disposal. The existing ground surface of the outdoor waste piles is characterized by bituminous concrete (asphalt) or Portland cement concrete pavement. The only remnant structures within the footprint of the Outdoor Waste Piles are two former equipment pedestals in area 1 (near the northwest corner of the Material Storage Building (MSB)) and Area 5, the former loading dock of the MSB. During the recent facility demolition, all paved site surfaces were cleaned to remove debris and sediment.

Thirty-one soil borings were conducted within the footprint of the Outdoor Waste Piles as part of the Closure Investigation plus seven borings performed as part of the RFI. To meet the closure criteria established for the HWMUs, soil remediation will be required at the areas depicted on Sheet 6 of the design drawings. As shown, excavation depths range from no removal to 7.25 feet, as measured from the existing ground surface.

Closure of the Outdoor Waste Piles will consist of removing the pavement covering the area to be remediated taking care to segregate the concrete pavement (including curb) from the asphalt pavement and separating the pavement from the subbase materials. After removal of the pavement, the Contractor will selectively excavate the underlying soil to the target removal depths. Spot elevations will be obtained at designated locations on the existing ground surface, prior to removal of the pavement and utilized as control points to guide the depth of excavation activities. The segregated asphalt pavement and excavated soil will be sent directly to the containment cell, placed in lifts and compacted to provide a stable surface. The segregated concrete will be crushed, placed in stockpiles (500 cy max.) and characterized for possible reuse as granular fill. Remnant concrete structures or foundations that may be encountered during excavation activities will be cleaned using hand tools to remove soil before being sent for crushing.

To document attainment of soil standards applicable to the HWMU Closure, post-excavation confirmatory sampling will be performed at the bottom of the excavations and along the side walls that are inside the footprint of the HWMUs. Sidewall sampling will not be performed on sidewalls that coincide with the horizontal limits of the HWMUs. Adequacy of sampling outside the limits of the HWMUs will be determined based on post-excavation confirmatory sampling requirements for on-site corrective measures described in Section 6.5. Post-excavation sampling will be performed in accordance with the procedures established in the Construction Quality Assurance Plan (Attachment D).

Following approval of confirmatory sampling information by the QA Representative, the resulting excavation will be backfilled with granular fill or structural soil fill to the proposed finished grades. Materials utilized for backfill within the limits of the Outdoor Waste Piles shall meet the remediation requirements for the HWMUs. The Contractor will protect the remediated area against cross contamination from surrounding areas.

6.4.2.2 **Indoor Waste Piles (Material Storage Building)**

The indoor waste piles were located in the Material Storage Building (MSB). The MSB was located at the north end of the main building (see Sheet 1). The MSB was approximately 165 feet by 165 feet with an enclosed corridor into the adjacent Furnace Room. The interior of the MSB included multiple bins used to store lead battery components awaiting processing through the furnace and various other raw materials (such as coke, iron and limestone or crushed concrete) also used in the smelting process. The MSB had concrete floors (typically 6 to 8 inches thick) sloped to drain from the exterior walls inward. During the various investigation activities, the concrete floor was observed to be degraded in the north central portion of the building, presumably a result of the acid in the lead battery feed material reacting with the concrete. The areas of greatest degradation coincide with the areas of proposed deepest excavations as shown on Sheet 6 of the design drawings.

As part of the recently completed decontamination and demolition activities, the 4 to 5 feet high concrete walls forming the exterior of the building and defining the interior bins were demolished to grade. The floor was filled with up to 18 inches of concrete rubble from other areas of the site that had been cleaned and crushed and then covered with a 20 mil PVC geomembrane. The crushed concrete was placed to create positive drainage for precipitation falling on the PVC geomembrane to the storm water collection system. The geomembrane is protected against wind uplift by approximately 300 to 400 sand bags. An estimated 500 to 600 cubic yards of crushed concrete rubble were placed over the MSB floor.

Closure of the indoor waste pile is expected to be one of the initial remedial activities to be performed after preparation of the disposal cell. Closure will consist of removing the PVC geomembrane and excavation of the crushed concrete rubble; removal of the concrete floor and excavation of underlying soils to the depths specified on Sheet 6 of the design drawings. The removal of the geomembrane, crushed concrete rubble and concrete floor will be performed in sections of a size to be determined by the Contractor based on his means and methods for construction. The geomembrane will be cut into sections no larger than 30 feet by 30 feet and placed flat (panels may be folded but not crumpled) in the bottom of the containment cell. The crushed concrete rubble and debris resulting from removal of the floor will be placed in the Containment Cell in loose lifts not to exceed 18-inches thick. Each lift will be compacted to provide a stable surface before the placement of subsequent lifts.

"Soil" removal within the MSB will be to a minimum depth of 12-inch (as measured from the top of the concrete pad) over the entire MSB footprint with specific areas as shown on Sheet 6 of the design drawings to depths as great as 72-inches. The total estimated removal volume within the MSB (excluding the rubble placed during decontamination and demolition) will be approximately 1,400 cubic yards (cy); including 700 cy of concrete representing the floor and 700 cy of soil and crushed aggregate excavated from beneath the concrete floor. The Contractor will be required to obtain spot elevations from the top of the concrete floor prior to removal for use in controlling depth of excavation. Confirmatory sampling will be performed at the bottom of the excavations and along side walls that are inside the footprint of the HWMUs to document attainment of closure criteria. Sidewall sampling will not be performed along sidewalls that coincide with the boundaries of the HWMUs where the exterior boundaries are not adjacent to other HWMUs.

Following approval of confirmatory sampling information by the Engineer, the resulting excavation will be backfilled with crushed stone or soil to the proposed finished grades. Backfill materials generated on-site and utilized for backfill within the limits of the MSB and other HWMUs shall meet the HWMU remediation criteria. Imported backfill material shall meet the IDEM RISC Residential Default Criteria. The Contractor will protect the remediated area against cross contamination from surrounding areas.

6.5 ON-SITE CORRECTIVE MEASURES

On-site corrective measures pertain to non-HWMU soil and "sediment" in the excavation areas located within RMC property boundaries as presented in Sheet 7 of the design drawings, excluding excavation within public and railroad right-of-ways. Non-HWMU soil excavation areas included the former manufacturing area (referred to as "On-Site Manufacturing Area" in the BHHRA), and lawn and wooded area (referred to "Grassy Area" in the BHHRA) of the Site that are outside of the HWMUs which exceed the calculated RALs of 8,470 and 4,954 mg/kg total lead, respectively. Although referred to as "sediment", the non-HWMU sediment excavation areas are generally mowed lawn on the site and small shallow storm water ditches with little or no actual sediment present in these features and the samples designated as "sediment" were most typically soil.

6.5.1 Soil Excavation

Excavation of on-site soils will require the removal of overlying floors and pavement in areas where subsoils exceed the RAL. Floors and pavement will be removed in a manner that minimizes disturbance of underlying soils. The concrete will be segregated from asphalt pavement and from the underlying subbase materials, crushed, stockpiled and sampled for potential use as excavation backfill. Sampling will be required to determine if the rubble meets backfill standards (see Specification Section 02210). Any rubble that does not meet the

Specifications will be placed in the containment cell or sent off-site for disposal. The areas of floor and pavement to be removed will be limited to only those areas requiring removal of subsoils. The Contractor shall provide sufficient dust control measures to ensure that the requirements for dust control identified in the Specifications and CQAP are met.

Soil excavation activities will be performed using commonly available construction techniques and readily available equipment and qualified labor. As required by the Specifications, the Contractor shall utilize appropriately placed silt fence, construction sequencing, storm water diversion and similar techniques to protect against erosion and transport potentially contaminated sediment from the site.

The Contractor will be required to develop specific measures to minimize the potential release of contaminants during excavation and exposure of on-site workers and off-site individuals in the immediate vicinity of the Site. Engineering controls such as staged construction, water misting for dust suppression, and proper use of personal protective equipment will be employed to mitigate exposures and potential releases during excavation.

6.5.2 Sediment Excavation

Excavation will be performed within the northern drainage ditches and the driveway ditch to remove "sediment" exceeding 400 mg/kg total lead. (As stated above, the drainage swales are generally mowed lawn on the site and small shallow storm water ditches along the CSX railroad tracks). Little or no actual sediment was present in these features. The samples were designated as "sediment" because they came from the bottom of the drainage swale, not because they represented significant bed load in the drainage ditch.

The northern drainage ditches are located along either side of the abandoned RMC railroad spur in the wooded area to the north. Historic activities are assumed to have conveyed surface water from the Site to the drainage ditches, depositing lead impacted solids along their span. The drainage ditches continue to receive storm water from the Site and flow north toward the CSX railroad line to the north. Three check dams consisting of geotextile and stone are located along the ditches. The check dams trap sediment upstream under current flow conditions and allow the passage of storm water downstream. Excavation in this area includes removal of the check dams within the lateral extents of the ditches. The stone, geotextile and accumulated sediment within the check dam will be placed in the containment cell with the remediated sediment/soil. The drainage ditches are located within a heavily wooded area and will require clearing to facilitate equipment access. Excavation to a depth of 12 inches and extending 5 feet on either side of the centerline of the ditches is expected to achieve sufficient remediation. Sediment excavation may require dewatering of the ditches and water removed during excavation will require testing prior to discharge or diversion. Sediment control measures may be required to reduce the potential for further contaminant migration during excavation.

The driveway ditch is located along the northern side of the main entrance to the Site, off of South Arlington Avenue. Boundaries of the ditch are fairly well defined in areas, and the area of proposed excavation is intended to include the ditch and the adjacent lawn area. The area continues to receive surface drainage and removal of standing water may be required prior to or during the course of excavation. Water removed during excavation will require treatment prior to discharge. Sediment control measures may be required to reduce the potential for contaminant migration during excavation.

Excavation in these areas will be performed using commonly available construction techniques and readily available equipment and qualified labor. The Contractor shall implement Best Management Practices (BMPs) during and after excavation activities to prevent erosion.

6.6 OFF-SITE CORRECTIVE MEASURES

Off-site corrective measures are presented in Sheets 7 and 8 of the design drawings and pertain to proposed excavation areas: within the mowed lawn drainage ditch along South Arlington Avenue, mowed lawn section of the Citzens Gas property between Big Four Road and Citizens Gas fence line; within portions of the northern drainage ditch outside of the RMC property boundary along the CSX right-of-way; and on the Citizens Gas property.

6.6.1 Remediation in Public Right-of-Ways

As shown on Sheet 7, approximately 1,500 feet of the mowed lawn drainage feature along South Arlington Avenue will require excavation of soil/sediment exceeding the USEPA residential screening level of 400 mg/kg lead in soil. Excavation will extend from the edge of pavement to the RMC fence line at varying depths of 6 to 18 inches, with depths generally increasing from north to south. Excavations along the South Arlington Avenue pavement deeper than 6 inches will be stepped in 6-inch increments to avoid damage or undercutting of the road way.

Remedial activities along South Arlington Avenue will involve use of the roadway for equipment access and material transport. As identified in this Design Report, a Right-of-Way permit will be required for this work. Under such permit, traffic control measures shall be implemented by the Contractor in accordance with the Indiana Manual of Uniform Traffic Control Devices. At a minimum, traffic control devices shall be installed prior to commencement of operations, be properly maintained and utilized during excavation and restoration activities, and be removed immediately upon completion. Careful consideration of excavation approaches will need to be exercised in this area due to the presence of overhead and subsurface utilities.

Careful planning with regard to weather forecasts and incorporation of erosion control techniques will be essential as this area receives considerable surface drainage.

6.6.2 Remediation Within Railroad Right-of-Ways

As shown in Sheets 7 and 8, remediation within the active railroad right-of-way includes excavation along the CSX line north of the Site. Excavation in the former right-of-way along Big Four Road, represents property owned by Citizens Gas and the track is inactive except for sporadic use by the adjacent Amtrak facility.

Remediation in the CSX railroad right-of-way consists of removal of sediment exceeding 400 mg/kg total lead within the drainage ditch paralleling the tracks, extending approximately 600 feet west of the northwest corner of the RMC property. Excavation in this area will necessitate proper identification of utility locations prior to commencement. Postings indicate that a Fiber Optics line is located along the tree line in this area. Excavation will be performed using conventional construction equipment. Dewatering of the swale and inclusion of sediment control methods may be necessary to facilitate excavation. Due to the geography of the area and close proximity to the tree line, additional clearing may be necessary to access for excavation. Access may best be achieved from the containment cell location.

6.6.3 Citizens Gas Property

Citizens Energy Group (Citizens) will record deed restriction for the Citizens property immediately adjacent to the west side of the site. The deed restriction will be recorded after RMC completes certain work agreed upon by Citizens on the Citizens property. The work is to be performed simultaneously with Corrective Measures Implementation at the site. The deed restriction shall prohibit the use of the Citizens property for any residential purpose including, but not limited to, residences, hotels or motels, hospitals or in-patient medical care, playgrounds or recreational facilities, or daily care facilities (e.g., day care centers, schools, senior citizen facilities, nursing homes, or assisted living facilities). Prior to filing the deed restriction, RMC and Citizens will ensure that the wording of the deed restriction is acceptable to both EPA and IDEM.

6.7 CONTAINMENT CELL CAPPING AND CLOSURE

The final grading of the cap will be dictated by the actual volume of soil, sediment and debris placed, and the results of interface friction testing for the selected cap geosynthetic and soil materials, but the maximum grading will not exceed that shown on Sheet 5 of the design drawings. Maximum slopes will be 33%. As filling progresses to elevations above the top of berm, the Contractor will be required to place temporary diversions to intercept storm water runoff from the exposed materials in the cell and convey that water to the temporary treatment system for processing. When final grades are reached, the finished surface will be smooth graded, rolled and protruding rocks or other objects that could puncture the geomembrane will be remove by the Contractor. Following approval of the finished surface by the QA Representative, the Contractor will be required to protect the area against vehicular traffic except to the extent necessary to deploy the liner components. Any damage to the approved surface will be repaired by the Contractor to the satisfaction of the QA Representative prior to geomembrane placement. The approved surface may be temporarily covered with plastic sheeting or non-woven geotextile until mobilization of the liner installer, provided such measures protect the surface against erosion. Any such temporary cover must be adequately balanced to protect against disturbance by wind or other causes.

The proposed cap will be a non-woven geotextile placed directly on the approved soil surface, a textured 60 mil HDPE geomembrane (Cap Barrier Layer); double sided drainage net (Cap Drainage Layer); 18-inches of compacted soil fill; 6-inches of topsoil; erosion control mat; and vegetative cover. The geomembrane and drainage net components of the cap will terminate in an anchor trench in the top of the berm. Infiltrating precipitation intercepted by the drainage net will be collect in a perforated pipe situated within the anchor trench. The perforated pipe will have outfalls periodically around the perimeter of the berm to discharge collected water. Specification Section 02751 provides requirements the Cap Drainage Layer; and Section 02755 provides requirements for the Cap Barrier Layer.

6.8 BACKFILL AND RESTORATION

6.8.1 Site Security Fence

During containment cell construction activities, the Contractor will be required to erect permanent site security fence along the common property boundary with the CSX right-of-way along the northern boundary of the site. The new fence will begin at the existing corner post for the Citizens Gas security fence and terminate at the existing corner post for the RMC fence along South Arlington Avenue. Actual alignment along the CSX right-of-way will be established based on property line survey to be completed by the Contractor's surveyor. Warning Signs shall be posted along the alignment of the perimeter security fence (new and old) as described in Specification Section 02831.

Additional security fence repairs and/or replacement will be made as required by RMC or required to facilitate proposed construction activities.

6.8.2 Containment Cell Exterior Berms, Drainage Swale and Access Road

The anticipated sequence of construction will result in the exterior berms, access road and drainage features being constructed prior to the start of site-wide and off-site remediation activities. The centerline of the 12 feet wide perimeter access road on the north and east sides of the containment cell will be located 10.5 feet from the western (common property line with

Citizens Gas) and northern property boundary (CSX right-of-way) as field located by the Contractor's surveyor. The access road and drainage swale will be constructed through cutting and filling with structural soil fill following the procedures provided in Specification Section 02210, to achieve a completed stable subgrade surface. The proposed culvert leading from the drainage swale into the storm water management basin outlet structure shall be installed (Specification Section 02720) during access road cutting and filling activities. The access road will have a cross-slope directing surface water runoff from the road to the proposed drainage swale. The access road surface will be stabilized utilizing geotextile fabric and On-Site Surface Stone Aggregate per Specification Section 02936. The area between the property boundary and the outside edge of the access road shall be graded to match existing grades along the fence and restored with On-Site Surface Stone Aggregate. The drainage ditch and outside face of the containment cell berms will be restored using sod installed in accordance with the requirements of Specification Section 02936.

6.8.3 Storm Water Management Basin

The storm water management (SWM) basin will be situated on the east side of the containment cell as shown on the design drawings. The SWM basin will include the sediment fore-bay, intended to receive runoff and enhance sedimentation; and a storm water detention area, intended to hold storm water runoff during controlled discharge. The Contractor is required to collect and manage storm water runoff from active work zones and disturbed areas of the site in accordance with the requirements of Specification Section 02715, to prevent the entry of potentially contaminated sediment or water into the SWM basin. The SWM Basin shall be constructed at time of site preparation after performing required soil remediation in excavation areas NW and ND1, clearing and grubbing, and stripping topsoil within the proposed area of disturbance.

The fore-bay will have a top elevation of 839.5 and bottom of 837.5 and provide approximately 0.5 acre feet of combined water and sediment storage. The fore-bay will be excavated after acceptable confirmatory sampling results have been received for the required soil remediation. Spoils generated during fore-bay excavation meeting the geotechnical requirements for structural soil fill can be utilized for construction of the containment cell berm, without the need for stockpiling and characterization sampling. The fore-bay will become inundated with water (either infiltrating groundwater during periods of high groundwater or surface water runoff) shortly after construction and therefore will not be vegetated or lined with stone. Sediment storage capacity of the fore bay will be maintained during corrective measures construction through periodic sediment removal as required based on sediment accumulation. A final cleaning will be performed when on-site soil remediation is completed. Removed sediment will be placed in the containment cell with the Contractor collecting and managing free liquid pursuant to Specification Section 02715.

The storm water detention area will be constructed concurrently with the sediment fore-bay area. The bottom of the detention area will require cutting to achieve required bottom elevations. Topsoil will be stripped, stockpiled and sampled to determine final disposition. The remaining subsoil will be cut as required to achieve the elevations shown on the design drawings. The detention area will have an outlet structure situated as shown on the design drawings. The outlet structure a precast concrete inlet box, will have a 12-inch diameter orifice plate (invert = 837.25) that will function as the discharge device for the detention basin. The 15-inch diameter CPE culvert from the containment cell drainage ditch will be connected directly to the outlet structure. A 15-inch diameter CPE pipe (invert elevation out = 837.15) will convey water from the retention basin and drainage ditch culvert to the railroad spur drainage ditch. The bottom of the retention area of the SWM Basin will be stabilized with On-Site Surface Stone Aggregate, as specified in Section 02936.

6.8.4 Surface Impoundment

Following receipt of acceptable confirmatory sampling results within the footprint of the lagoon and adjacent on-site corrective measures excavation area OE1, the remaining depression will be backfilled and surrounding area restored. Backfilling within the former lagoon footprint will be performed using granular fill or structural soil fill below elevation 840 (as dictated by geotechnical conditions and discretion of the QA Representative) and using structural soil fill above. Care shall be taken to prevent disturbance of the lawn areas outside the exclusion zone fence. Finished grading shall promote drainage of surface water runoff towards the pavement proposed to remain in place (Sheet 9) and is expected require minimal amounts of cutting in the OE1 excavation area. Materials used as backfill will be placed in lifts and compacted in accordance with the project earthwork specifications (Section 02210).

6.8.5 General On-Site Surface Restoration

Following completion of remediation, the Site areas will be regraded to allow surface water to runoff from the site to the drainage ditches along the CSX right-of-way and South Arlington Avenue without the use of the pump houses. Existing pavement will remain in the areas of the site not proposed for soil remediation except to the extent required to facilitate post remediation storm water drainage. Rough grading will be performed by cutting and filling the ground surface remaining after completion of soil excavation activities. The Contractor will be permitted to "borrow" structural soil fill from completed excavation areas FL-2, FL-3, FL-4A and FL-5, and will backfill the resulting excavation with excess topsoil (stripped from within the area of the containment cell and storm water management basin demonstrated to have a total lead concentration <920 mg/kg and antimony, arsenic, cadmium and selenium equal to or less than the HWMU closure values). The volume of borrow will be dictated by the volume of excess topsoil. The finished surface on-site will be restored with On-Site Surface Stone Aggregate, the only exceptions being the areas between the interior and exterior security fences along South

Arlington Avenue which are proposed for turf restoration. On-site drainage ditches will be lined with Drainage Ditch Aggregate. The requirements for drainage ditch aggregate, on-site surface stone, and turf are provided in Specification Section 02936.

6.8.6 Off-Site Backfill and Restoration

Off-site areas will be restored to the pre-remediation condition unless otherwise approved by the property owner. Backfill will consist of imported structural soil and stone and imported topsoil and/or sod. The drainage ditch along South Arlington Avenue will be restored using sod. The drainage ditches along the CSX right-of-way will be restored using rip-rap stone in the bottom and railroad ballast on the embankment and surrounding ground surface. Information regarding the physical and analytical requirements for aggregate and soil used for restoration are provided in the Specifications.

6.9 SITE DEED RESTRICTION

Upon completion of site soil and sediment remediation and associated restoration, RMC will record a restriction on the deed for the RMC property. The deed restriction will restrict the use of the property to only commercial/industrial land use, and prevent installation of on-site potable groundwater wells.

7.0 PERMITTING REQUIREMENTS

This section describes federal, state, regional, and local permits and approvals required for implementation of Corrective Measures. This section also discusses site access and easement agreements or other arrangements with adjoining landowners necessary for implementation of Corrective Measures. A discussion of the application requirements and timeline for each item is provided below.

7.1 FEDERAL PERMITS

At this point in time, no federal permits are anticipated.

7.2 STATE PERMITS

7.2.1 Rule 5 – General National Pollutant Discharge Elimination System (NPDES) Permit for Storm Water Run-off Associated with Construction Activity

Indiana Administrative Code Rule 5 (327 IAC 15-5) is a performance-based regulation designed to reduce pollutants that are associated with construction and/or land disturbing activities. The requirements of Rule 5 apply to all persons who are involved in construction activity (which includes clearing, grading, excavation and other land disturbing activities) that results in the disturbance of one (1) acre or more of total land area.

RMC will submit application under Rule 5, which will include the following:

- Notice of Intent Letter
- Construction Plan

- Project Narrative and supporting documents
- Vicinity Map
- Existing Project Site Layout
- Final Project Site Layout
- Grading Plan
- Drainage Plan
- Storm Water Pollution Prevention Plan
- Post Construction Storm Water Pollution Prevention Plan

7.3 CITY OF INDIANAPOLIS PERMITS

7.3.1 Office of Code Enforcement

7.3.1.1 **Drainage**

The Office of Code Enforcement (Office) requires that land alterations be compliant with standards and practices that result in proper storm water drainage and sediment control. The Office has indicated through conversation with AGC that a Mass Earthwork Permit may apply for Corrective Measures. The Mass Earthwork Permit is a drainage permit for projects involving earth disturbance without the construction of buildings. As a general rule, all land alterations in industrial developments require:

- Storm water permit application
- Storm water plans
- Technical information report
- Sediment and erosion control plan
- BMP operation and maintenance manual

As per the Office, construction observation services, testing, and 'record' drawings shall be provided for all industrial developments that plan land disturbance of 5 acres or more.

Once construction begins, the Contractor will be responsible for informing and/or notifying the Office's observer assigned to the following:

- Daily work schedule including any changes in schedule
- Prior notification if work is to be performed on weekends and/or holidays
- Date mandrel tests are to be performed
- Date 'as-built' verification is to be performed

The Office, upon request of the Contractor and/or owner, will schedule the final inspection.

As per Office direction, RMC will submit application for a Drainage Permit which will include completion of the following forms:

- Certification Sufficiency of Plan (Drainage)
- Certificate Obligation to Observe (Storm Water)
- Infrastructure Plan Review Submittal

Upon review of RMC's submission, the Office will determine if the Marion County Soil and Water Conservation District will be involved in the review process. Upon approval, the Office will provide RMC with an Approval Letter, which will need to be included in RMC's Notice of Intent (NOI) submittal to the Indiana Department of Environmental Management (IDEM) for Rule 5 General Construction NPDES Permit application.

7.3.1.2 **Improvement Location Permit**

Temporary office trailers will be required to support Corrective Measures activities. A permit will not be required for these trailers as the Office designates "movable, temporary use structures or buildings utilized during construction projects" as specific exemptions that do not necessitate an Improvement Location Permit. However, the Office stipulates that all provisions and regulations of the City of Indianapolis Industrial Districts Zoning Ordinance shall continue to apply to exempted structures and improvements.

7.3.1.3 **Right-of-Way Permit**

RMC will submit application for excavation within the South Arlington Avenue public right-of-way which will include, at a minimum, the following:

- A properly executed permit application, in the form designated by the Marion County Department of Code Enforcement Department, including but not limited to, the following information:

  - The name and address of the contractor responsible for work;
  - The nature of, and the reason for, the work to be performed;
  - The location of the worksite and the dimensions of the excavation;
  - The anticipated length of time to complete the work;
  - The method of traffic control to be used by the applicant at the worksite;
  - An indemnification agreement; and,
  - Any other pertinent information requested by the Department.

- A general liability insurance policy.

- A performance and maintenance bond.

- Approval from the Department if the proposed work involves a sanitary sewer, storm sewer, affects drainage within the public right-of-way, or as required.

7.3.2 Department of Metropolitan Development

7.3.2.1 **Industrial Districts Zoning Ordinance**

The Site is designated as an I-3-S Medium Industrial Suburban District and I-4-S Heavy Industrial Suburban District and the Official Thoroughfare Plan for Marion County designates South Arlington Avenue as a Primary Arterial. The proposed containment cell will fall in both the I-3-S and I-4-S zoning districts. Although not representing a "structure" as defined under the zoning regulations, the cell has been situated to provide 30 feet of set back from the north and west property lines which represent the side and back yards of the property respectively. The setback from South Arlington Avenue, as measured from the centerline of the proposed berm will be approximately 190 feet at its closest point. The areas within the setbacks will be utilized as storm drainage and storm water management controls.

The containment cell does not appear to represent a "use" under the Industrial Zoning Ordinances, although both zoning districts include provisions for "industrial waste disposal facilities." The Performance Standards for both districts state that plans and specifications for proposed industrial waste disposal facilities shall be submitted to, and written approval obtained from, IDEM and the City of Indianapolis, Division of Compliance before an Improvement Location Permit will be issued. The final CMD will be submitted to the City of Indianapolis division of Compliance for written approval.

7.4 CITY OF BEECH GROVE PERMITS

Conversations with the City of Beech Grove and the City of Indianapolis indicate that, due to the nature of corrective measures, jurisdiction of the majority of work to be performed will be with the City of Indianapolis, Division of Compliance. No permits are expected to be required except for temporary facilities mobilized for completion of the work, although the City will be provided copies of the Final CM Design to confirm the representations made during the initial conversations.

8.0 PUBLIC RELATIONS

Refined Metals Corporation (RMC) developed a Community Relations Plan as an attachment to the RFI Work Plan. Components of the existing Community Relations Plan include a document repository (currently located at the Beech Grove Public Library), semi-annual news letters to a specified mailing list, maintaining open communications with local officials, and conducting public meetings when warranted based on the level of public interest.

9.0 SCHEDULE AND COST ESTIMATE

9.1 SCHEDULE

Based on the corrective measures activities anticipated by this Final Corrective Measures Design, RMC is anticipating a construction period on the order of 4 to 6 months, although ultimately schedule will be dictated by the approach of the selected contractor. A critical path style schedule has been developed and is provided as Attachment G.

9.2 COST ESTIMATE

A preliminary construction cost estimate is provided as Attachment F. The cost estimate has been developed using a unit price and estimated quantity format. As shown, the September 2010 estimate is $1,159,744.

10.0 POST CORRECTIVE MEASURES STORM WATER MANAGEMENT

Post corrective storm water management will consist of a gravity storm water system that will convey storm water runoff from the former impervious manufacturing areas of the site and the eastern portion of the proposed containment cell cap through a storm water management basins situated along the east side of the proposed containment cell. The storm water management basin will cover approximately 1.2 acres and have a storage capacity of approximately 80,000 cubic feet. The outlet structure will be a 15-inch diameter reinforced concrete pipe with an invert elevation of 837.25 that discharges into the railroad ditch along the CSX property. The proposed discharge towards the north coincides with the original storm water discharge for the manufacturing areas of the site prior to construction of the storm water collection and treatment system.

Swales will convey the storm water runoff from the restored areas of the site to the storm water management basin as shown on Sheet 6. The total drainage area to the basin is 9.5 acres with an average CN value of 91. Pondpack® was utilized to perform the storm water management calculations following the SCS Unit Hydrograph Method. As presented on the calculations (Attachment C), the basin will detain the storm event and attenuate the flows as follows:

DESIGN STORM	INFLOW (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	STORAGE (Ac-ft)
2	24.9	3.28	838.50	0.594
5	37.31	4.08	838.92	0.946
10	43.51	4.43	839.13	1.132
25	52.78	7.08	839.38	1.367
50	58.93	9.68	839.54	1.512
100	68.12	12.32	839.78	1.742

In addition to the flows through the storm water management basin, approximately fifty percent of the containment cell cap will drain into a trapezoidal swale along the west and north sides of the cell, before draining through a 15" ∅ culvert. The swale will function as a storm water management basin for the 1.3 acre area as follows.

DESIGN STORM	INFLOW (cfs)	OUTFLOW (cfs)	ELEVATION (ft)	STORAGE (Ac-ft)
2	2.61	1.61	838.37	0.031
5	4.27	2.49	838.66	0.052
10	5.13	2.85	838.79	0.063
25	6.44	3.27	838.99	0.083
50	7.31	3.47	839.10	0.097
100	8.63	3.75	839.28	0.120

11.0 POST CLOSURE INSPECTION AND MAINTENANCE

The post closure inspection and maintenance plan is provided as Attachment E.

ATTACHMENT B

Construction Specifications
Replacement Pages

SECTION 01010

SUMMARY OF WORK

PART 1: GENERAL

1.1 DESCRIPTION OF WORK

The Work to be performed under these Specifications represents the proposed Corrective Measures to be completed by Refined Metals Corporation (RMC) to address elevated concentrations of lead and associated inorganic compounds in soil, sediment and groundwater identified on and around the RMC facility in Beech Grove, Marion County, Indiana. Major components of the Work include the following:

A. Installation and maintenance of erosion and sediment control measures, storm water management controls, temporary access controls, and decontamination facilities associated with the proposed work.

B. Clearing, grubbing and disposal of brush and trees from within areas of proposed remediation and containment cell construction.

C. Construction of a containment cell for consolidation of excavated soil, "sediment", and designated debris.

D. Excavation of on-site soil exceeding 970 mg/kg total lead, 37 mg/kg antimony, 20 mg/kg arsenic, 77 mg/kg cadmium and 53 mg/kg selenium within HWMU areas, as shown on the Hazardous Waste Management Unit Closure Plan (Sheet 6).

E. Closure of the on-site surface impoundment (lagoon) and demolition of its concrete liner component following removal of liquid, bulk sediment, vegetation, liner material and miscellaneous debris.

F. Excavation of on-site soil from areas outside the HWMUs exceeding 4,954 mg/kg total lead in "grassy" exposure areas and 8,470 mg/kg total lead in paved exposure areas, as shown on Soil and Sediment Excavation Plan East (Sheet 7).

G. Excavation of soil and "sediment" exceeding 400 mg/kg total lead in off-site areas, as shown on Soil and Sediment Excavation Plans East and West (Sheets 7 and 8).

H. Handling, loading, transporting and placement of excavated materials in the containment cell.

I. Identification of borrow sources for; and procurement of topsoil, structural soil fill, general site fill, cap soil fill, and granular fill meeting the requirements of these Specifications.

J. Restoration of those areas of the site disturbed as a result, directly or indirectly, of the soil excavation activities and associated work.

K. Mobilization and operation of a temporary water treatment system for accumulated stormwater and groundwater from disturbed site areas and decontamination water.

L. Operation of existing storm water management system (pumps and piping) from the time of mobilization through site stabilization and initiation of gravity storm water drainage through proposed discharge features.

M. Establish stormwater drainage and management system capable of capturing, controlling and discharging stormwater runoff without the use of pumps.

1.2 RELATED SECTIONS

A. Corrective Measures Design (including all Attachments)

B. All Sections of these Specifications

1.3 CONTRACTOR RESPONSIBILITIES

A. Furnish all materials, tools, equipment, supervision, administration and transportation, and perform all labor and services necessary to furnish, deliver, construct, install, and/or complete all Work described in the Contract.

B. As necessary for proper execution and completion of work and as applicable, secure and pay for required permits, licenses, health and safety training, and medical monitoring for its own employees working at the site.

C. Provide at least 2 weeks advanced notification of commencement of mobilization.

D. Locate and protect existing utilities prior to working in or adjacent to areas containing existing utilities pursuant to the requirements of the Indiana One-Call system and through the use of a private utility locator.

E. Until final acceptance of the Work by RMC, the Contractor shall have the charge and care thereof and shall take every reasonable precaution against injury or damage to the completed work. The Contractor shall repair, restore, and make good, to the satisfaction of RMC all damages to any portion of the work before final acceptance and shall bear the expense thereof.

F. Contractor shall provide experienced, competent and trained personnel to perform the Work. Contractor shall provide, at a minimum, a project superintendent familiar with all details of the project, adept at the designated position and capable of communicating with Contractor personnel, and representatives of RMC, USEPA, and IDEM.

G. Contractor shall be responsible for providing barriers, safety guards, signage and temporary fencing as required by the owners of the properties where work is being performed, and as required by appropriate safety regulations.

1.4 CONTRACTOR USE OF WORKSITE

A. General

1. The Contractor shall confine operations at the site to areas indicated on the design drawings and shall not unreasonably encumber the site with any materials or equipment.

2. The Contractor shall limit their work on properties not owned by RMC to between the hours of 7:00 a.m. and 6:00 p.m., Monday through Friday, except legal holidays. Work on RMC property shall be limited to 6:00 a.m. to 7:00 p.m., Monday through Friday and Saturday 7:00 a.m. to 5:00 p.m., unless otherwise restricted by local ordinance. Additional working hours, or work on Sundays will only be permitted with prior approval by RMC.

3. Keep existing driveways and entrances serving the site clear and available at all times.

4. Consider the safety of the Work, and that of people and property on and adjacent to worksite, when determining amount, location, movement,

installation, and use of materials and equipment on worksite. Work zone safety fencing shall be used to demark active work zones outside the site security. Within the site security fence the Contractor shall provide protection around work zones in accordance with applicable regulatory statutes and as necessary to prevent uncontrolled access.

5. Site security shall be the Contractor's responsibility. RMC will maintain part-time dusk to dawn security service that consists of an unarmed guard visiting the site at irregular intervals during the night. RMC is not responsible for security of Contractor's equipment and materials.

6. Protect the general public from construction-related activities, conduct work in a manner, which will ensure that pedestrian and vehicular traffic will either not be obstructed or obstructed to the least possible degree.

7. Work on non-RMC property will be subject to limits and restrictions imposed by property owner.

1.5 EXISTING CONDITIONS

A. The existing conditions represented on the design drawings are based on the best available information obtained from one or any combination of the following sources: field survey, aerial photographs, reference drawings, or visual evaluations. The Contractor shall retain an Indiana Licensed Professional Surveyor to document starting conditions and establish vertical and horizontal controls for the project.

B. If conditions are significantly different to those presented on the design drawings such that they could affect the schedule, cost or execution of the work, the Contractor shall submit a detailed description of the conditions observed within two work days of their identification.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

Not Used.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01050

FIELD ENGINEERING

PART 1: GENERAL

1.1 DESCRIPTION

A. Work included: This Section of the Specifications covers field engineering services required for proper completion of the Work including, but not limited to:

1. Establishing and maintaining lines and levels, including field locating the property north and west of the proposed Containment Cell.

2. Surveying pre-removal conditions (topography and physical features) within the limits of contaminated soils and sediment designated for removal, and establishing reproducible grids or cross-sections for controlling removal depths.

3. Documenting final removal limits using the grids and cross-sections described above.

4. Providing As-Built Drawings of restored site conditions as part of the final project closeout. As-Built Drawings shall also document the finished surface of the materials placed in the Containment Cell and top of the finished cap.

5. Structural design of shores, forms, and similar items provided by the Contractor (if any) as part of the means and methods of construction.

6. The Contractor will retain the services of an Indiana Licensed Professional Surveyor to perform pre-removal and as-built surveys. The Contractor may utilize his own equipment and personnel to provide grade control during excavation activities and document final removal limits, provided the techniques and equipment are acceptable to the QA Representative and tied into the vertical and horizontal controls established by the surveyor.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals

B. Section 02110 - Site Clearing and Grubbing

C. Section 02115 - Erosion and Sediment Control Measures

D. Section 02209 - Excavation/Handling/Placement

E. Section 02210 - Earthwork

F. Section 02831 – Fencing

1.3 DEFINITIONS

A. As-Built Drawings – Drawings at a similar scale and level of detail as the design drawings showing an accurate record of all deviations from the approved design drawings and Specifications which may occur in the Work as actually constructed. The Contractor will be provided with electronic copies of the design drawings for use in development of the As-Built Drawings. As-Built Drawings shall be signed and sealed by the Contractor's surveyor.

1.4 QUALITY ASSURANCE

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. A land surveyor licensed to practice in the State of Indiana shall be directly responsible for survey work performed by the Contractor.

C. RMC will retain the services of a full-time Quality Assurance (QA) Representative to observe and document progression of the work and collect required post-excavation samples and perform other activities specifically designated in the Construction Quality Assurance Plan (CQAP) and Specifications.

D. The Contractor will be responsible for providing appropriately qualified personnel to perform Quality Control (QC) testing throughout the project, including performing air monitoring, compaction testing, liner installation and material testing.

1.5 SUBMITTALS

A. Comply with the pertinent provisions of Section 01300.

B. The Contractor shall provide, at a minimum, As-Built Drawings, signed and sealed by the Contractor's Surveyor, for the following components:

1. The initial excavation/removal work areas documenting original conditions.

2. Areas of clearing and grubbing and demolition quantities.

3. The final elevations of the site and off-site work zones and limits of each type of restoration (i.e., seeded vegetation, sod, and crushed stone/concrete).

4. All the reasonable items requested by RMC to verify that the Work meets the requirements of the Contract.

The Contractor shall submit As-Built documentation for review by RMC, with the request for final payment or at the completion of the applicable phases of the work.

C. The Contractor shall prepare a Daily Report detailing any and all work and health and safety activities that were performed. **The Daily Report shall be prepared by noon the following work day and a copy submitted to the QA Representative**. Results of Quality Control sampling and testing shall be provided as attachments to the Daily Report.

D. Contractor shall prepare and submit a Construction Schedule presenting the planned sequence for execution of the work. The Construction Schedule shall identify the sequence of excavation activities on a removal area by removal area basis, planned start and end dates for each major tasks, and other relevant information required for control of the work. The schedule shall be updated at least every two weeks to show actual versus planned progress and reflect changes in the schedule.

PART 2: MATERIALS

Not Used.

PART 3: EXECUTION

Not Used.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01200

PROJECT PROGRESS MEETINGS

PART 1: GENERAL

1.1 DESCRIPTION OF WORK

A. The Contractor will conduct project meetings throughout the construction period to enable orderly review during progress of Work and to provide for systematic discussion of problems. Project meetings will also include discussions regarding coordination and scheduling.

B. When requested by a property owner, the Contractor will be required to participate in a Pre-Construction Meeting specific to that property. At a minimum, this will include a meeting for work on Citizens Gas property. The agenda for such meetings will be established by RMC and the property owner. RMC will be responsible for issuing minutes for such meetings.

1.2 RELATED SECTIONS

A. All documents related to the Corrective Measures Design.

1.3 QUALITY ASSURANCE

A. The Contractor's Superintendent shall attend and participate in each project meeting and shall represent the Contractor consistent with the Contract and commit the Contractor to solutions and actions agreed upon during the project meetings.

B. The Contractor's relations with its subcontractors and discussions relative thereto, are the Contractor's responsibility. The Contractor will be required to include key subcontractors (such as the liner installer) in project meetings when related work is being planned or discussed.

1.4 SUBMITTALS

A. Agenda items:

1. To the maximum extent practicable, the QA Respresentative will advise the Contractor at least twenty-four (24) hours in advance of project meetings regarding items to be discussed during the meeting.

2. Technical questions requiring the QA Representative's, Engineer's or RMC's response shall be submitted in writing, at least one (1) day prior to the project meeting.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

3.1 MEETING SCHEDULE

A. Project meetings will be held weekly at a regularly scheduled time and day to be mutually agreed upon between the Contractor, RMC and regulatory agencies. When work is being performed, planned, or discussed on non-RMC property, the property owners will also be invited to participate in the project meetings. From time to time or during periods of reduced activity, the frequency of the meeting may be switched to bi-weekly. The day and time of the meetings may be moved with concurrence of the Contractor, RMC, USEPA and IDEM.

3.2 MEETING LOCATION

A. The Contractor shall provide adequate space at the site for progress meetings and provide conference call capabilities for participation from remote locations.

3.3 PROJECT MEETINGS

A. Minimum agenda for each meeting:

1. Attendance

2. Review of safety issues/concerns and latest sampling results.

3. Review progress of Work since last meeting, including status of submittals for approval.

4. Identify problems, which impede planned progress.

5. Develop corrective measures and procedures to regain planned schedule, if applicable.

6. Contractor shall provide and discuss "two-week look ahead" activity schedule if the work is not progressing per the early start/finish activity dates as noted in the latest update of the approved schedule.

7. Complete other current business.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01300

SUBMITTALS

PART 1: GENERAL

1.1 DESCRIPTION

A. This Section of the Specifications covers all submittals including material specifications and manufacturer's data; proposed subcontractors qualifications and insurance information, panel placement plan for geomembrane installation, sequence of construction information, schedule, and borrow source testing information. Contractor shall make submittals utilizing a standardized transmittal form acceptable to the QA Representative.

B. Upon award of the Contract, but no later than fourteen (14) calendar days before mobilization the Contractor shall prepare a submittal register for review and approval by the QA Representative.

1.2 RELATED SECTIONS

A. The appropriate Sections of Division 1 and Division 2 of these Specifications.

1.3 SUBMITTAL REGISTER

A. The submittal register shall be submitted no later than fourteen (14) calendar days before mobilization. The submittal register shall include all submittal items listed in the Specifications and shall also provide the following information, at a minimum:

1. Project name;
2. Contractor's project or reference number;
3. Submittal title and description of item and Specification section;
4. Submittal reference number sequentially numbered; and
5. Columns for submittal date, response date and approval status.

B. The submittal register shall include blank rows for future addition of submittals that were not anticipated. Upon inclusion of additional line items in the submittal register, the Contractor shall resubmit an updated submittal register for use by RMC and the Engineer.

1.4 SUBMITTAL SCHEDULE

A. The Contractor is required to make submittals sufficiently in advance of delivery of associated materials or commencement of associated work to allow review and response by the QA Representative. While the QA Representative will strive to turnaround submittals as quickly as possible, the Contractor should anticipate that submittals will require 5 days for review and response. Submittals that are considered incomplete or item unacceptable will be returned and will require resubmission.

1.5 SUBMITTALS

A. The minimal information required for each submittal is found in its respective Section of these Specifications. The following is a partial list of submittals related to the project:

1. Construction Schedule and Narrative Sequence of Construction
2. Contractor's Health and Safety Plan
3. Subcontractor's Qualifications and Insurance Information
4. Temporary Water Treatment System Information
5. Geotechnical and Analytical Data for Proposed Borrow Sources
6. Manufacturers Specifications and Cut-Sheets for Materials
7. Geomembrane Installer's Panel Placement Plan
8. As-Built Drawings

B. A submittal cover sheet or transmittal sheet shall accompany each submittal and shall include all information specified in these Specifications. The transmittal sheets shall be sequentially numbered and shall be of the same format for all submittals.

C. Submittals will be reviewed by the QA Representative. Where appropriate, the QA Representative will solicit input from RMC or the Engineer regarding the adequacy/acceptability of the proposed item.

D. The Contractor shall apply a stamp or signature certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the Contract Documents.

E. The results of review of submittals will be used as follows:

1. NO EXCEPTIONS TAKEN;
2. PROCEED AS NOTED; REVISE AND RESUBMIT FOR RECORD;
3. DO NOT PROCEED; REVISE AND RESUBMIT;
4. REJECTED; or,
5. NOT APPLICABLE.

F. Submittals not in compliance with the Specifications will be returned to the Contractor for revision. Any loss of time and additional costs associated with resubmittal(s) are the Contractor's responsibility.

G. Submittals that are "Proceed as Noted" are for the purpose of expediting procurement of the intended work. The Contractor shall incorporate all corrections and resubmit revised submittal to QA Representative within seven (7) calendar days of the "Proceed as Noted" action. Payment for completed work that is related to the "Proceed as Noted" submittal will not be made until the corrected and final resubmittal is accepted in writing by the QA Representative.

1.6 SUBSTITUTIONS

A. "Or Equals" Substitutions

1. Equals Considered - Whenever a material or article required is specified or shown on the plans by using the name of the proprietary product or of a particular manufacturer or vendor, any material or article which will perform adequately the duties imposed by the general design, will be considered equal and satisfactory provided the material or article so proposed is of equal properties and function in the opinion of QA Representative.

2. The Contractor shall document each request with complete data substantiating compliance of the proposed Substitution with the Contract Documents. "Or Equal" requests will be considered only when substantiated by the Contractor's submittal of data documenting the "Or Equal" nature of material or article. A request constitutes a representation that the Contractor:

   a. Has investigated the proposed product and determined that it meets or exceeds the quality level of the specified product.

   b. Shall provide the same warranty for the substitution as for the specified product.

   c. Shall coordinate installation and make changes to other work, which may be required for the Work to be complete with no additional cost to RMC.

   d. Shall waive claims for additional costs or time extension, which may subsequently become apparent.

   e. Shall reimburse RMC for review or redesign services associated with review and approval.

   d. Shall waive claims for additional costs or time extension, which may subsequently become apparent.

3. The Contractor shall provide substitutions in a timely manner and in accordance with the CMD and the Contract with RMC, so as to not have a negative impact on the Construction Schedule.

1.7 PRODUCT DATA

A. Collect product data into a single submittal for each element of fabrication or system. Product data includes printed information such as manufacturer's installation instructions, catalog costs, standard color charts, roughing-in diagrams and templates, standard wiring diagrams and performance curves.

B. Mark each copy to show applicable choices and options. Where product data includes information on several products, some of which are not required, mark copies to indicate the applicable information.

C. Do not submit product data until compliance with requirements of the Contract Documents has been confirmed.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

3.1 IDENTIFICATION OF SUBMITTALS

A. The Contractor shall consecutively number all submittals.

1. When resubmittal(s) is made for any reason, the Contractor shall transmit under a new letter of transmittal with a new transmittal number.

2. On resubmittals, the Contractor shall cite the prior transmittal number(s).

B. The Contractor shall maintain an accurate submittal log for the duration of the Work, showing current status of all submittals at all times. The Contractor shall make the submittal log available for review upon request.

3.2 GROUPING OF SUBMITTALS

A. Unless otherwise specified, the Contractor shall make submittals in groups containing all associated items to assure that information is available for checking of each item when it is received.

B. Partial and poorly prepared submittals will be rejected as not complying with the requirements of the Contract. The Contractor will be liable for related delays.

3.3 TIMING OF SUBMITTALS

A. In scheduling, the Contractor shall allow five (5) calendar days for review and processing by the QA Representative following its receipt of the submittal.

This review time will be increased for the submittal(s) that are so extensive that the five (5) calendar day turn around period is unreasonable, as determined by the QA Representative.

C. It is understood that work affected by the submittal may progress only after the QA Representative has returned the approved, signed and stamped transmittal cover sheet to the Contractor. The Contractor will be responsible for the repair, modification or removal of completed work, which had not been approved.

3.4 QA REPRESENTATIVE'S REVIEW

A. Review and Processing shall not relieve the Contractor from responsibility for errors, which may exist in the submitted data.

B. Revisions:

1. The Contractor shall make required revisions as noted on initial submittal.

2. If the Contractor considers any required revision to be a change, it shall so notify RMC in writing within 3 calendar days.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01351

HEALTH AND SAFETY PLAN REQUIREMENTS

PART 1: GENERAL

1.1 DESCRIPTION

A. The Work of the Contract covered by this section shall include the development and implementation of a Health and Safety Plan (HASP) for all proposed Corrective Measures activities contemplated as part of the proposed Work. The Contractor shall provide all expertise, supervision, labor, materials, and equipment necessary to develop, prepare, and implement the Health and Safety Plan as detailed in this Section and as accepted by USEPA, IDEM and RMC.

B. The Contractor shall develop and implement all necessary precautions for the safety of, and provide the necessary protection to prevent damage, injury or loss to:

- All employees and subcontractors participating in performance of the Work.
- All components of the Work, any materials to be used or incorporated in the Work, and any equipment to be employed in the execution of the Work, whether on- or off-site.
- Other property on or adjacent to the project site including trees, shrubs, lawns, fences, sidewalks, pavements, roadways, structures and utilities not designated for removal, relocation, or replacement in the course of construction.
- Adjacent property of owners/landowners and residents.

1.2 RELATED SECTIONS

A. All of the CM Design (including all attachments).

B. United States Federal Government - Code of Federal Regulations (CFR)

1. 29 CFR 1910 – Occupational Safety and Health Standards

2. 29 CFR 1910.120 - Hazardous Waste Operations and Emergency Response

3. 29 CFR 1910.134 - Respiratory Protection

4. 29 CFR 1910.1200 - Hazard Communication

5. 29 CFR 1926 - Construction Standards

6. 29 CFR 1910.1025 – Lead in Construction

1.3 QUALITY ASSURANCE

A. The Contractor's draft Health and Safety Plan (HASP) will be reviewed for content by the USEPA, IDEM and RMC. Each will return comments within one week from receipt of the draft HASP.

B. The Contractor shall carefully review and consider all elements of the Work of the Contract during preparation of the HASP and verify that all elements of the Contract Documents are thoroughly addressed. Incomplete or missing elements in the HASP will create delays in approval which will delay the commencement of Work.

1.4 GENERAL PLAN REQUIREMENTS

A. The Contractor shall develop a written site-specific HASP which complies with applicable regulations under the Code of Federal Regulations prior to commencing any on-site work and continue to implement, maintain, and enforce the HASP until final demobilization from the site.

B. The health and safety guidelines contained herein are intended to provide for a safe and minimal risk working environment for on-site personnel and to minimize the impact of activities involving contact with excavated soils on the general public and the surrounding environment.

C. The Contractor shall be responsible for the safety of persons and property on the site and for the protection of persons off the site and the environment to the extent that it may be affected by the conduct of the Work. The Contractor shall comply with and enforce compliance by employees of the Contractor and subcontractors with safety requirements of the CMD, laws and regulations, and HASP.

D. Hazard Communication Requirements:

1. The Contractor shall comply with the requirements of OSHA's Hazard Communication rule, 29 CFR 1910.1200, obtaining information on any hazardous chemical or harmful physical agent to which personnel of the Contractor and subcontractors, and visitors have potential exposure during the Work.

2. The Contractor shall include Material Safety Data Sheet (MSDS) documentation on any hazardous chemicals that the Contractor and/or its subcontractor's plan to utilize for the Work. In addition, the Contractor shall be responsible for meeting container warning label requirements in accordance with OSHA.

E. Work Stoppage: The Contractor shall give precedence to the safety and health of the public and on-site personnel and the protection of the environment for all Work. The Contractor's designated health and safety officer shall be responsible for decisions regarding when the Work will be stopped and re-started for health or safety considerations. The Contractor shall be responsible for all costs and delays at no extra cost to RMC.

F. Unforeseen Hazards: Should any unforeseen or site-specific safety-related factor, hazard, or condition become evident during performance of the Work at the Site, the Contractor shall bring such to the attention of RMC verbally and in writing as quickly as possible, for resolution. In the interim, the Contractor shall take prudent action to establish and maintain safe working conditions and to safeguard employees of Contractor and its subcontractors, the public, the property owner, RMC and its representatives, and regulators.

1.5 BASIS OF PROGRAM

A. OSHA standards and regulations contained in 29 CFR 1910 and 1926 provide the basis for the health and safety program. The program also reflects the position of USEPA and NIOSH regarding procedures recommended or required to ensure safe operations at sites containing hazardous or toxic materials.

1.6 SITE CHARACTERIZATION

A. Based on past sampling activities, work at the site will involve contact with materials containing lead, arsenic and other metals. Results of soil and sediment sampling are provided in the design drawings.

1.7 SUBMITTALS

A. The Contractor shall submit the draft Health and Safety Plan (HASP) in electronic format to RMC for review and comment at least two weeks prior to the start of work. The Contractor's HASP shall include; but is not limited to, required drawings, figures, tables, forms, resumes and appendices.

B. The Contractor shall not proceed with the Work until RMC, the USEPA and IDEM have accepted the Contractor's HASP.

C. The Contractor's HASP shall be a stand alone document that correlates health and safety procedures to each work element in a clear and concise manner.

D. Health and Safety Plan shall include the following:

1. Site control measures in accordance with 29 CFR 1910.120 (d) and 29 CFR 1926.65 (d).

2. A safety and health risk or hazard analysis for each site task and operation, including measures or controls for each task/operation.

3. Personnel training assignments in accordance with 29 CFR 1910.120 (e) and 29 CFR 1926.65 (e), 29 CFR 1910.1001 (j), and 29 CFR 1910.1025 (l).

4. Personal protective equipment to be used by personnel for each site task and operation being conducted in accordance with 29 CFR 1910.1209 (g)(5) and 29 CFR 1926.65 (G)(5).

5. Medical surveillance requirements in accordance with 29 CFR 1910.120 (f) and 29 CFR 1926.65 (f).

6. Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment to be used.

7. Decontamination procedures in accordance with 29 CFR 1910.120 (k) and 29 CFR 1926.65 (k).

8. A written respiratory protection program for project activities.

9. Procedure for dealing with heat and/or cold stress.

E Air Monitoring Reporting: **<u>Submit daily</u>**, on a separate Contractor designated form, air monitoring results.

PART 2: PRODUCTS AND PERSONNEL

2.1 DESIGNATED HEALTH AND SAFETY OFFICER

A. Employ and assign to the Work a competent and authorized representative herein referred to as the Health and Safety Officer. Health and Safety Officer Qualifications:

1. Site-related working experience specific to the activities associated with soil remediation projects.

2. Have a basic working knowledge of state and federal occupational safety and health regulations.

3. Have formal education and/or training in occupational safety and health.

B. Health and Safety Officer Responsibilities:

1. Obligated to stop or start the work when it is necessary or advisable for reasons of health or safety.

2. Completing daily health and safety training sessions (i.e. "tailgate meetings").

3. Implementing and daily enforcement and monitoring of the site-specific HASP.

4. Be on the site during the execution of Work at the site.

2.2 PERSONNEL HEALTH, SAFETY, AND HYGIENE

A. Medical Surveillance: Conduct medical surveillance of personnel as required by 29 CFR 1910.120, 29 CFR 1926.65, and 29 CFR 1910.134.

B. Training: Furnish personnel assigned to or entering the site who have successfully completed training required by the applicable OSHA Standards in 29 CFR 1910 and 29 CFR 1926 and specifically with 29 CFR 1910.120 and 1926.65.

C. Levels of Protection: Establish actual levels of protection for each task based on planned activity and location of activity.

D. Personal Protective Equipment (PPE):

1. Furnish on-site Contractor personnel with appropriate PPE. Clean and maintain safety equipment and protective clothing. As a minimum, each worker on-site shall wear a hard hat, safety glasses with side shields, safety boots with steel toes and shank, and full-length pants.

2. Develop protective equipment usage procedures and enforce strict compliance with such procedures by on-site personnel.

E. Respiratory Protection

1. Furnish on-site personnel with training in the usage and limitations of, and qualitative fit testing for, air purifying and supplied-air respirators in accordance with 29 CFR 1910.134.

2. Develop, implement, and maintain a written respiratory program in accordance with 29 CFR 1910.134.

3. Monitor, evaluate, and provide respiratory protection for on-site personnel, as appropriate.

4. Immediately notify RMC if level of respiratory protection required increases from Level D to Level C.

F. Heat Stress/Cold Stress: Implement a heat stress and/or cold stress monitoring program as applicable and include in the site-specific Health and Safety Plan.

G. Personnel Hygiene and Personnel Decontamination Procedures.

1. Provide, as a minimum, the following:

a. Suitable containers for storage and disposal of used disposable PPE.

b. Potable water and a suitable sanitation facility.

H. Emergency and First-Aid Equipment

1. Locate and maintain emergency and first-aid equipment in appropriate location on the site, including:

a. First-Aid kit to accommodate the number of on-site personnel.

b. ABC type dry chemical fire extinguishers.

2. As a minimum, provide one (1) certified first-aid technician on the site at all times when on-site work activities are in progress. This technician may perform other duties but shall be immediately available to render first aid when needed.

I. Site Communications:

1. Post emergency numbers near the site telephones.

2. Furnish selected personnel with 2-way radios.

J. Safety Meetings: Conduct mandatory daily safety meetings for on-site personnel, and additionally as required by special or work-related conditions; include refresher training for existing equipment and protocols, review ongoing safety issues and protocols, and examine new site conditions as they are encountered. Hold additional safety meetings on an as-needed basis.

K. The Contractor shall be responsible for keeping safety equipment and facilities clean, properly equipped, and maintained. The Health and Safety Officer may perform other duties for Contractor but the first priority shall be maintenance of protective equipment and the personnel decontamination area.

2.3 AIR MONITORING

A. The Contractor shall develop an air monitoring program meeting the requirements of 29 CFR 1910.120 (h) and 29 CFR 1926.65 (h).

B. The Contractor shall monitor the progress of work activities, monitor air quality in and around the exclusion zone. The Contractor shall conduct all required air monitoring.

C. The Contractor shall provide the required instruments for air monitoring including, but not limited to, as a minimum:

1. Dust monitor (mini Ram or equivalent).
2. High-Volume Air Monitors

D. The Contractor shall operate air monitoring equipment with personnel trained in the use of the specific equipment provided under direct control of the Contractor's health and safety officer.

E. The Contractor shall conduct all required air monitoring during the Work of the Contract.

2.4 SITE CONTROL

A. The Contractor shall comply with 29 CFR 1910.120 (d) and 20 CFR 1926.65 (d).

B. The Contractor shall provide in the HASP a figure or map which presents the delineation of the work zones for Project activities considered in the Work of the Contract.

C. The Contractor shall provide in the HASP a discussion on Site security issues.

D. The Contractor shall provide in the HASP a detailed discussion on decontamination procedures for both equipment and personnel, including collection and disposal of wash waters and spent PPE.

PART 3: EXECUTION

3.1 HEALTH AND SAFETY PLAN

A. The Contractor shall prepare a written Health and Safety Plan which is applicable to all components of the Work. The HASP shall be based upon the requirements and guidelines described herein and all provisions of applicable law. The Contractor's HASP will apply to all personnel on-site including the Contractor and its subcontractors, RMC and its representatives, the property owners, the USEPA, the IDEM and other regulatory agencies. The Contractor shall include additional information as appropriate and may utilize any format provided it is neat, clean and complete.

B. The Contractor shall ensure that the HASP meets, at a minimum, the requirements of OSHA Standards and Regulations contained in Title 29, Code of Federal Regulations, Parts 1910 and 1926 (29 CFR 1910 and 1926).

C. In addition, the Contractor's HASP must include at a minimum, the following information:

- Responsibilities of the Contractor and its Health and Safety Officer and the name of the Health and Safety Officer and assistant health and safety personnel to be utilized on site.

- A description of the Work to be performed at the Site and how health and safety activities are related to the work.

- A hazard evaluation, including discussions of potential hazards involved with the Work.

- A discussion of proposed environmental and personnel monitoring including specific types of equipment to be used and action levels to be instituted.

- Personnel protection requirements for specific work areas, specific activities or specific tasks. The Contractor shall supply all personal protective equipment.

- Personnel and equipment decontamination procedures.

- Training requirements for personnel utilizing personal protective equipment. The Contractor shall provide 40 hours of classroom training supplemented with site-specific training as required by OSHA in 29 CFR 1910.120 for all personnel who will be working on-site prior to their initiating on-site work. Additionally, the Contractor's supervisory personnel shall receive an additional 8 hours of supervisory training.

- Daily and weekly safety logs and a closeout safety report to be prepared by the Contractor.

3.2 IMPLEMENTATION OF PLAN

A. Once the Health and Safety Plan (HASP) has been accepted by RMC, the USEPA and the IDEM, then the requirements of the HASP shall be enforced and the Contractor shall commence the remediation activities.

B. The Contractor shall provide an on-site Health and Safety Officer during all Work activities, appropriately trained and certified for supervisory responsibility in health and safety protection. An alternate Health and Safety Officer, with appropriate training, must be designated to serve when the Health and Safety Officer is not on-site.

C. It shall be the responsibility of the Contractor's Health and Safety Officer to ensure that all health and safety requirements are implemented per the approved HASP.

D The Contractor's Health and Safety Officer shall be responsible for personnel decontamination and emergency response measures.

E. The Contractor's Health and Safety Officer shall have the authority to act on all health and safety issues and matters, and to establish new controls, procedures or facilities as needed.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01355

WASTE MANAGEMENT AND DISPOSAL PLAN REQUIREMENTS

PART 1: GENERAL

1.1 DESCRIPTION

The proposed Work is not expected to generate a significant volume of waste materials requiring offsite disposal or recycling. The only anticipated waste materials requiring off-site management will be minor amounts of scrap metal destined for recycling, general refuse generated by the temporary office facilities and materials generated during the clearing and grubbing process. Depending on the amount of impacted soil excavated and the ultimate capacity of the containment cell, off-site disposal of some soil/sediment/debris may be required.

1.2 RELATED SECTIONS

A. Section 01300 - Submittals

B. Section 01351 - Health and Safety Plan Requirements

C. Section 02110 – Site Clearing and Grubbing

D. Section 02150 – Demolition of Remnant Structures

E. Section 02209 - Excavation/Handling/Placement

1.3 SUBMITTALS

The Contractor shall submit for RMC approval the names and permit information for all proposed disposal or recycling facilities. Submittal shall include copies of current operating permits and proof of insurance for the facility and the name and contact information of regulatory inspectors.

PART 2: PRODUCTS

2.1 WASTE STORAGE AND SHIPPING CONTAINERS

A. The Contractor's containers utilized to store and transport the various waste materials shall be appropriately sized and compatible with the material being managed and approved for the intended use by the Department of Transportation.

PART 3: EXECUTION

3.1 GENERAL

A. Soil, sediment and miscellaneous debris generated during the remedial activities will be placed in the Containment Cell in accordance with the procedures contained in Specification Section 02209.

B. Only materials approved by the QA Representative will be released for off-site management.

C. The proposed corrective measures will require the removal of more than 2,000 cy of concrete pavement, floor slabs and wall (excluding the MSB floor). It is the intent of RMC as part of its "Green Remediation" efforts to segregate, crush and reuse the concrete. Specific information to the procedures related to the segregation, crushing and recycling are provided in Section 02150. If concrete can not be recycled because it fails analytical requirements established in the Specifications for re-use it shall be disposed in the Containment Cell.

D. The Contractor's submittals for proposed off-site recycling or disposal facilities shall include:

1. Characterization sampling required by each facility for each type of waste and the name and qualifications of the laboratory to provide the required analysis.

2. Waste management requirements for each waste stream including labeling, manifests and bills of lading, and record keeping.

3. Name, address, telephone number, contact name, copy of operating permits and proof of insurance for each proposed disposal facility.

4. Names, address, telephone numbers, contact name, copy of operating permits and proof of insurance for each proposed transporter.

5. Description of transportation operations for each waste material.

3.2 PREVIOUSLY UTILIZED DISPOSAL AND RECYCLING FACILITIES

During the decontamination and demolition activities, the following facilities were utilized:

1. Metals Recycling – OmniSource
2. Non-Hazardous Solid Waste – Southside Landfill Inc.
3. Hazardous Solid Waste – Heritage Environmental Services

PART 4: MEASUREMENT AND PAYMENT

Measurement and payment shall be as indicated in Specification 02110.

END OF SECTION

SECTION 01400

QUALITY ASSURANCE/QUALITY CONTROL

PART 1: GENERAL

1.1 DESCRIPTION

A. Work Included:

The Contractor shall establish and maintain a project specific Quality Control (QC) and management program (collectively QC program) for each component to be furnished and installed under the Contract Documents. Contractor shall have the "primary" responsibility for the quality of all its work and ensure that all materials meet the requirements established in these Specifications.

B. RMC will provide a full-time Quality Assurance Representative (QA Representative) to observe and document work activities and the Contractor's QC program. The Contractor shall be responsible for the implementation QC requirements of the Corrective Measures Design. The Contractor shall not rely on RMC's QA Representative to satisfy the requirements of these Specifications, except as it relates to the collection and analysis of post-excavation samples, which will be performed by the QA Representative.

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work

B. Section 01050 - Field Engineering

C. Section 02209 – Excavation/Handling/Placement

D. Section 01300 – Submittals

E. Section 02210 – Earthwork

F. Section 02751 – Cap Drainage Layer

G. Section 02755 – Cap Barrier Layer

H. Section 02936 - Site Restoration

1.3 DEFINITIONS

The following definitions pertain to requirements of this Section.

A. Quality Assurance (QA):

Quality Assurance is a planned and systematic pattern of activities (for example, approved surveillance and audit requirements) designed to assure and document that the Quality Control (QC) of items or procedures are being performed in accordance with the approved remedial design and that the product of the construction will perform satisfactory in service and will meet the highest quality standards. This Section also provides a methodology for resolving problems which may occur during construction. The Construction Quality Assurance Plan (CQAP) outlines the procedures and requirements for QA.

B. Quality Control (QC):

Quality Control is defined as those actions taken by manufacturers, fabricators, installers and contractors that provide a means (for example, through examining, witnessing, inspecting, checking and testing of in-process or completed work) to measure performance and to demonstrate that the characteristics of an item or service meet the contractual and regulatory requirements, as well as to document the results. Specific QC procedures and requirements are outlined in these Specifications. The Contractor performs Quality Control.

1.4 SUBMITTALS

A. The Contractor shall submit the names and qualifications of the personnel retained by the Contractor to conduct Quality Control activities. At a minimum this is expected to include geotechnical engineering testing services (i.e. compaction testing) and geomembrane installation quality control. If the geomembrane installation QC is conducted by the liner installer, the qualification of the installers QC representative shall be submitted with the liner installer company's qualifications.

1.5 SITE QUALITY CONTROL

A. The Contractor shall identify an individual within its organization at the site of the Work, who shall be responsible for overall management of Quality Control.

B. Material arriving at the site shall be inspected and documented to conform to the Contract requirements. Nonconforming and damaged material shall be segregated and removed from the site.

C. The Contractor shall protect all materials and equipment from rust, corrosion and similar damage.

D. The Contractor shall, as soon as the material arrives at site (but before beginning installation), provide to RMC the original bill of lading and required certifications stating that the material complies with the requirements of the Contract Documents.

E. The Contractor shall perform necessary and specified tests as received and shall document the results. The Contractor shall replace material that fails the tests.

F. Remove and replace new or existing material that is damaged in storage or in the performance of Work unless specifically accepted in writing by QA Representative.

G. No Work shall be performed at the Site if the Contractor's Superintendent, or his designee, is not present at the site.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

3.1 DATA MANAGEMENT AND DOCUMENTATION

A. General

The Contractor will be responsible for documenting that the quality control requirements of this project have been addressed and satisfied. The Contractor will be responsible for ensuring that the quality control documentation is complete and accurate with adequate documentation.

The Contractor's QC reporting will include descriptive remarks, data sheets, and logs to verify that the monitoring activities have been carried out in accordance with the Specifications and Construction Quality Control Plan. Performance standards established for the project will need to be demonstrated. The

Contractor will also maintain at the job site a complete file of plans and specifications, the Contractor HASP, the Contractor's checklists, test procedures, daily logs, and other pertinent materials that will be used to document conformance with the approved design drawings and specifications for this project.

The Contractor will prepare progress logs and test data sheets daily, as appropriate and provide such information as attachments to the Daily Field Reports. At a minimum, these reports will include the following information:

- Descriptions and locations of ongoing construction;
- Data on weather conditions;
- Equipment and personnel in each work area, including subcontractors;
- Descriptions and specific locations of areas, or units, or work being completed, tested and/or observed and documented;
- Locations where any tests and samples were taken; and a summary of tests results;
- Calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;
- Delivery schedule of relevant construction materials received, including quality control documentation for appropriate materials;
- Decisions made regarding acceptance of units of work, and/or corrective actions to be taken in instances of substandard quality; and,
- Signature.

The QA Representative will be made aware of any significant recurring non-conformance. The QA Representative will work with the Contractor to determine the cause of the non-conformance and recommend appropriate changes, such as revisions to procedures or specifications.

B. Design and/or Specification Changes

Design and/or specification changes may be required during construction. In such cases, the Contractor will notify RMC, who will coordinate with the Engineer regarding the nature of and reasons for the required change. Design and/or specification changes will be made only with the written agreement of RMC (following review and consultation with all appropriate parties such as the Engineer, USEPA and IDEM), and, if necessary, will take the form of an addendum to the Corrective Measures Design.

C. Contractor's Final QC Report

At the completion of the Work, the Contractor's Project Manager will submit to RMC a final QC report. This report will include:

- A certification that the Work has been performed in compliance with the Corrective Measures Design
- Physical sampling and testing have been conducted at the appropriate frequencies;
- Observation logs and testing data sheets including the Contractor's sample location plans; and
- As-Built drawings (See Section 01050).

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1: GENERAL

1.1 DESCRIPTION

A. Work included:

The Contractor shall provide temporary facilities and controls needed for the performance of its Work including, but not necessarily limited to:

1. Temporary utilities such as water, electricity, and telephone;
2. Field office for the Contractor's personnel;
3. Sanitary facilities;
4. Enclosures such as tarpaulins, barricades and canopies;
5. First-aid facilities;
6. Temporary fencing and other safety devices for pedestrian and vehicular traffic as well as isolating the construction area;
7. Entry Control limiting access to authorized construction personnel;
8. Dust and Pollution Control and Monitoring Equipment;
9. Erosion and Sediment Control;
10. Water Control;
11. Health and Safety measures as required by the Contractors approved Health and Safety Plan;
12. Creation and maintenance of access roads.

1.2 RELATED SECTIONS

A. Section 01010 - Summary of Work

B. Section 01300 - Submittals

C. Section 01351 – Health and Safety Plan Requirements

D. Division 2 of these Specifications

1.3 SUBMITTALS

A. The Contractor shall provide a plan showing the proposed layout for the temporary facilities for review and approval by RMC prior to start of mobilization.

1.4 PRODUCT HANDLING

The Contractor shall maintain and protect all temporary facilities and controls in proper and safe condition throughout progress of the Work.

1.5 TEMPORARY UTILITIES AND SERVICES

A. Water: Water lines are in place and operable up to the fire hydrant situated near pump house #4, although service has been discontinued. In order to perform the Work of the Contract, the Contractor shall be responsible for restoration of water service to the site prior to commencement of remedial activities and shall be responsible for discontinuation of water service following successful completion of remedial activities. The Contractor shall absorb all costs associated with water service restoration and cancelation, and the costs of the water usage during any phase of the Work of the Contract.

The Contractor shall also provide, maintain, and pay for potable water (e.g., bottled water) for each of the Contractor supplied office trailers and for all work personnel.

B. Sanitary Facilities:

1. The Contractor shall provide, and pay for all portable sanitary accommodations for all Contractor personnel on the project, including RMC representatives, and regulatory agencies. Facilities shall be located

in areas convenient to personnel and approved by RMC. The Contractor is to provide at least one portable sanitary unit per trailer and one unit shall be provided for every fifteen (15) employees of the Contractor. The units shall be cleaned and maintained by the Contractor in a sanitary condition and at a minimum frequency of twice per week.

C. Temporary Power and Lighting:

1. The Contractor shall provide all temporary electricity necessary to complete the Work as detailed in the Specifications and on the design drawings. The Contractor may connect to local electrical sources or may provide on-site generators; however, the temporary electrical supply method must be approved by RMC and must also meet federal, state, and local regulations. The Contractor's electrical service shall not be subject to voltage fluctuations capable of damaging electrical equipment.

2. The Contractor shall provide temporary lighting for the support (i.e., trailers), access, parking, and active work areas. The provision of lighting in the active work areas does not necessarily permit the Contractor to work after sunset without the prior written approval of RMC and the Engineer.

3. The Contractor shall pay all costs associated with the utility tie-ins, physical plant, maintenance of system throughout construction, power usage during the work, removal of same at project completion and any other items necessary in providing temporary power and light. The temporary power and lighting system shall at all times conform with the applicable codes and regulations of OSHA, NEMA, UL, and the local municipality.

D. Telephones:

1. The Contractor shall make necessary arrangements and pay costs for installation, maintenance and operation of direct line (non pay type) telephone services in the Contractor's field office at the site. Telephone service in main office trailer shall be suitable for conferencing during weekly progress calls.

1.6 ACCESS, STORAGE AND PARKING AREAS

A. The Contractor shall establish a construction Compound. The Contractor shall submit to RMC a plan layout of the Compound for RMC approval prior to mobilization.

B. The Contractor shall coordinate the provision of utility services for all trailers and be responsible for all installation charges, removal costs at Project completion, and any periodic or other charges incidental to the provision of those utility services.

C. Contractor shall provide lighting for the Contractor compound areas.

D. Routes of ingress and egress within the Site shall be clearly marked and protected by the Contractor as required by the Section 02100. Temporary roads to the construction areas shall be constructed and maintained by the Contractor. These roads may be extended and relocated as Work progresses, as long as traffic flow is unimpeded. The Contractor shall maintain both access and temporary construction roads in adequate condition such that vehicular and pedestrian traffic can safely and easily negotiate the roads. Conditions which should be corrected by the Contractor shall include, but are not be limited to, excessive ponding water, excessive dust generation, potholes, or excessive mud, snow, or debris. All access and temporary construction roads shall be removed and restored

E. Upon final acceptance of the Work, the Contractor shall clean up the work areas and leave them in a neat and orderly condition. The Contractor shall dismantle and remove all temporary fencing and barricades and other temporary items installed, unless otherwise directed by RMC. Repair damaged areas to their original condition.

1.7 FIELD OFFICES AND SHEDS

A. Contractor's Field Office:

Furnish and maintain a field office with a telephone at the site during the entire period of construction. Keep readily accessible at the field office copies of both the Contract Documents and the latest approved shop and working drawings.

B. RMC's Field Offices

The Contractor shall provide at least 100 sf of field office space for use by RMC's on-site representatives. Such space may be located in the same trailer as the Contractor's field office but must include a lockable door, desk surface with at least one 2-drawer file cabinet and two chairs.

1.8 ENCLOSURES AND TEMPORARY FENCING

A. The Contractor shall provide all storage necessary for materials and equipment associated with the Work, as specified in individual specification sections and as recommended by the respective manufacturers. Protection for materials, equipment, and completed Work shall be provided by the Contractor in addition to any special protection where specified in individual specification sections.

1.9 TEMPORARY SIGNAGE (CONSTRUCTION)

A. The Contractor shall provide, maintain, and pay for all barricades, temporary fencing, railings, warning lighting, signage and other similar items necessary to protect all areas required and to comply with OSHA guidelines for safe working environments for both site personnel and onlookers and to prevent unauthorized entry onto the Site or work zones.

1.10 PROTECTION OF NEW AND EXISITNG IMPROVEMENTS

A. The Contractor shall protect all areas on and off the Site that may be damaged by its activities. This shall include, but not be limited to, streets, roads, monitoring wells, Site entrances, existing fence and gates, railroad right-of-ways, existing drainage features, adjacent properties, previous site improvements, sidewalks, utilities, trees, plants, lawns or other maintained areas. The Contractor shall also protect all off-site and clean on-site areas from cross-contamination by vehicular tracking, erosion, or any other mechanism, manmade or natural. Any areas or items that are impacted by the Contractor's activities shall be repaired or replaced at the Contractor's expense.

B. Temporary and removable protection shall also be provided, as necessary. The Contractor shall control activity in the immediate work area to prevent damage or contamination. Traffic should be prohibited from completed or protected areas. Any damage to materials, equipment or completed Work shall be repaired or replaced at the Contractor's expense. The Contractor shall delineate work zones using temporary orange snow fence and posts with warning signs as approved by RMC and the Engineer.

1.11 POLLUTION AND DUST CONTROL

A. The Contractor shall supply all expertise, labor, equipment, and materials necessary to control the spread of contamination and to control the generation of excessive noise, dust or odor emissions. Dust control shall be conducted in order to maintain all work areas free from dust which would contribute to air pollution. Approved temporary methods of dust control consisting of sprinkling, water treatment, or similar methods will be permitted. Sprinkling, where used, must be repeated at such intervals as to keep all parts of the disturbed area at least damp at all times. Dust control shall be performed as the work proceeds and whenever a dust nuisance or hazard occurs.

B. The Contractor shall provide and maintain decontamination stations for the proper decontamination of all equipment, personnel, and materials leaving a contaminated work zone. This includes, but is not limited to, all pumps, power washers, storage tanks and Contaminant Reduction Zone.

C. The Contractor shall provide all necessary expertise, supervision, labor, materials, and equipment and shall perform all work activities in such a manner as to minimize the amount of noise, dust, or odor generated from the Site. The Contractor shall also ensure that the levels of noise, dust, and odor and methods of mitigating them are in accordance with federal, state and local regulations.

1.12 EROSION AND SEDIMENT CONTROL

A. The Contractor shall provide Erosion and Sediment controls as required by the Corrective Measures Design to protect the Site from erosion and to prevent contaminated particles from exiting the Site.

1.13 WATER CONTROL

A. The Contractor shall provide water control throughout the duration of the Contract in accordance with the Water Management During Construction Section 02715.

1.14 SECURITY

A. The Contractor shall be responsible for maintaining existing security fencing and gates for adequate protection of and restriction of access to all areas of the site, including support zones and active/inactive work areas, by unauthorized persons or vehicles throughout the Work. Security fence maintenance shall protect the Work and existing facilities from unauthorized entry, vandalism, or theft.

B. The Contractor shall be solely responsible for security of its equipment and work. RMC currently maintains a part-time security service consisting of one to three site visits by an unarmed guard between dusk and dawn. RMC does not maintain responsibility for protection of Contractor equipment, materials, or completed work.

1.15 PROGRESS CLEANING

A. The Contractor shall incorporate a cleaning program for the support facility and work areas of the Site on a periodic basis. The cleaning methods and frequency shall be adequate to maintain all areas of the Site, including maintaining the interior of trailers free of waste materials, debris, and rubbish, and generally safe, clean, organized and workable. Upon final acceptance of the Work, the Contractor shall clean up the work area and leave it in a neat and orderly condition.

B. The Contractor shall provide trash service involving at least one eight (8) cubic yard dumpster to be emptied once a week. The Contractor may need to provide more extensive trash collection measures during peak periods of construction so that the dumpster is not overflowing at any point in time.

1.16 FIRE PREVENTION CONTROL

A. The Contractor shall take all precautions necessary to prevent fires and explosions. All open flame, welding, and heating operations shall be performed in accordance with OSHA standards. The Contractor shall provide and maintain dry chemical type fire extinguishers in the immediate vicinity of any flame or spark producing operations and also in each of the office trailers. All flammable liquids shall be stored in accordance with OSHA standards. Gasoline shall be transported and stored in OSHA approved containers only.

PART 2: PRODUCTS

Not Used.

PART 3: EXECUTION

Not Used.

PART 4: MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Construction facilities and temporary controls shall not be measured.

4.2 PAYMENT

Mobilization shall include all expertise, supervision, labor, materials, and equipment necessary to be in accordance with this section of the Specifications, including establishment of the support zone. Progress payments will be made on a percent complete basis as determined by RMC. Mobilization shall be complete when Site preparation is being conducted at the rate shown in the Contractor's schedule.

PAY ITEM	UNIT
Mobilization	Lump Sum

END OF SECTION

SECTION 02720

SITE STORMWATER SYSTEM

PART 1: GENERAL

1.1 DESCRIPTION

This section covers work associated with the installation of the proposed storm water management basin outlet structures, culverts, flared end sections and outlet protection/rip rap aprons.

1.2 RELATED WORK

A. Section 01050 - Field Engineering

B. Section 01300 - Submittals

C. Section 01351 - Health and Safety Plan Requirements

D. Section 01400 – Quality Assurance/Quality Control

E. Section 02100 - Site Preparation

F. Section 02115 - Erosion and Sediment Control Measures

G. Section 02209 - Excavation/Handling/Placement

H. Section 02210 – Earthwork

I. Section 02936 – Site Restoration

1.3 DEFINITIONS

ASTM - American Society for Testing and Materials

CQAP - Construction Quality Assurance Plan

OSHA - Occupational Safety and Health Administration

1.4 QUALITY ASSURANCE

Quality Control activities for installation of the site storm water features shall be performed by the Contractor in accordance with the pipe manufacturer's installation requirements and relevant section of these specifications. Products used for construction of storm water systems, including piping materials, pre-cast-concrete structures, bedding materials and backfill shall comply with specific parameters contained in these Specifications. The QA representative will review the manufacturer's installation procedures and review Contractor's installation procedures for consistency therewith.

1.5 REFERENCES

ASTM A48 - Specification for Gray Iron Castings

ASTM D421 - Test Method for Dry Preparation of Soil Samples for Particle-Size Analysis and Determination of Soil Constants

ASTM D2487 - Procedure for Classification of Soils for Engineering Properties

1.6 SUBMITTALS

Contractor shall submit pipe manufacturers recommended installation procedures to QA Representative for review and approval.

1.7 PRODUCT HANDLING

All products required for construction of the proposed culvert and storm water management basin outlet structure shall be handled in accordance with manufacturers' recommendations.

PART 2: PRODUCTS

2.1 STRUCTURAL SOIL FILL

Structural soil fill shall be used for backfilling over and around pipes and structures associated with the site storm sewer system. Structural soil fill shall meet the requirements of the earthwork section of these specifications (Section 02210).

2.2 BEDDING

AASHTO #57 crushed stone shall be used for the Corrugated Polyethylene (CPE) pipe bedding, base support for inlet box and backfill where required.

2.3 PIPE

A. The Corrugated Polyethylene (CPE) pipe shall be ADS –12, fifteen (15)-inch diameter pipe or engineer approved alternate with bell and spigot joints, soil tight fittings.

B. Flared end sections shall be manufactured or approved for use with the CPE pipe and utilize compatible fittings.

2.4 INLET STRUCTURE AND TOP UNIT

A. Inlet structure utilized for the storm water management basin outlet structure shall be a precast concrete 2' x 4' inlet structure for use with designed piping (size and material specified in design) with matching concrete frame (without curb) constructed using minimum Class AA precast concrete. Inlet structure shall be placed on eight (8) -inches of AASHTO #57. Inlet structure shall have a medium duty cast gray iron grate compatible with proposed frame.

2.5 RIP-RAP

Stone utilized as rip-rap shall match the requirements for material size and type as required for Drainage Ditch Aggregate as described in Specification Section 02936.

PART 3: EXECUTION

3.1 PREPARATIONS

A. The Contractor shall have completed clearing and grubbing and rough grading for the containment cell berm, drainage ditch and perimeter access road.

B. Temporary storm water management measures shall be installed and fully operational for the purpose of collecting and managing storm water runoff from active work zones and disturbed site areas.

C. Railroad rail and ties shall be removed from the location where proposed storm water pipe will cross railroad spur.

3.2 INSTALLATION

A. Excavation and Bedding

1. The Contractor shall ensure that the trenches are excavated to the lines and grades as shown on the Drawings.

2. The trench shall be excavated in such a manner as to be safe for personnel to enter the trench for installation of the piping. OSHA and all other applicable regulations including the Health and Safety Plan shall apply to this and all site activities.

3. Material excavated from the trench and structure sub-base and not used as backfill shall be segregated for use as structural soil fill with approval from the QA Representative.

4. Construct 6-inch thick layer of bedding by placing the AASHTO #57 material in a single lift over the approved stable subgrade. If subrgade is unstable, section shall be over excavated to a stable bottom and backfilled with AASHTO #57. Compact with a mechanical tamper. Form a cradle in the bedding material for piping by means of a template conforming to the curvature of the outside surface of the bottom of the pipe to provide uniform contact under and around the pipe. A minimum of eight (8)-inches of bedding shall be placed beneath proposed structures.

B. Pipe Placement

1. The Contractor shall excavate and construct proposed pipe as detailed on the design drawings. Pipe installation shall be in accordance with manufacturer's recommendations. Lay pipe in the cradle formed as specified above with bells up grade. Begin and end pipe at flared end sections or inlet structures as shown on drawings.

2. Control the pipe alignment and grade with suitable string lines, with an electronic laser beam system, or by other acceptable methods. Laser must be utilized for slopes less than two (2) percent.

3. Provide one (1)-foot minimum cover over the top of pipe for the storm sewer pipe.

4. Backfilling may proceed immediately after placement maintaining pipe in proper alignment and grade.

5. When pipes are connected with pre-cast concrete structures, cut off exposed pipe ends flush with the structure face and finish the inside and outside voids between the pipe and the precast opening with mortar.

C. Backfilling

Backfill shall be placed in lifts and compacted by the Contractor according to the requirement of Section 02210.

3.3 OUTLET PROTECTION

A rip rap apron (4 feet wide x 4 feet long x 9 inches thick shall be constructed at both the up-slope and down-slope flared end sections. The subbase for the rip-rap apron shall be lined with geotextile fabric.

PART 4: MEASUREMENT AND PAYMENT

Not Used.

END OF SECTION

SECTION 02751

CAP DRAINAGE LAYER

PART 1: GENERAL

1.1 DESCRIPTION

The Work covered by this section includes installation of the cap drainage layer for the containment cell cap systems. This includes manufacture, fabrication, packaging, delivery, and installation of all components. Specific components include the composite drainage layer (geonet/geotextile composite), perforated anchor trench drain, granular fill, and geotextile.

1.2 RELATED SECTIONS

A. Section 01050 - Field Engineering

B. Section 01300 - Submittals

C. Section 02210 - Earthwork

D. Section 02755 - Cap Barrier Layer

1.3 REFERENCES

ASTM D413 -	Test Method for Rubber Property-Adhesion to Flexible Substrate
ASTM D422 -	Test Method for Particle-size Analysis of Soils
ASTM D1682 -	Test Method for Strip Tensile Strength
ASTM D2487 -	Procedure for Classification of Soils for Engineering Purposes
ASTM D3776 -	Test Method for Mass per Unit Area (Weight) of Fabric
ASTM D4354 -	Standard Practice for Sampling of Geosynthetics for Testing
ASTM D4533 -	Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4595 -	Test Method for Tensile Properties of Geotextiles by the Wide Width Strip Method
ASTM D4632 -	Test Method for Breaking Load and Elongation of Geotextiles (Grab Method)
ASTM D4716 -	Test Method for Constant and Hydraulic Transmissivity of Geotextiles and Geotextile Related Products
ASTM D4751 -	Test Method for Determining Apparent Opening Size of a Geotextile

ASTM D4759 -	Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4833 -	Test Method for Index Puncture of Geotextiles, Geomembranes and Related Products
ASTM D5321 -	Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

1.4 SUBMITTALS

A. The Contractor shall submit Manufacturer's literature and specification for perforated piping to the QA Representative for approval. A minimum of four weeks prior to cap installation, the Contractor shall submit Manufacturer's specifications and physical property information for the composite drainage layer to the QA Representative for approval.

B. The Contractor shall have a geosynthetics testing laboratory perform shear box testing pursuant to ASTM D5321, for the soil/composite interface, composite/geomembrane interface, geomembrane/geotextile interface and geotextile/soil interface and shall include the results with the submittal for approval by QA Representative prior to delivery of materials to the site. Shear box testing shall be run at 3 psi, 1.5 psi, and 0.5 psi using site specific materials.

1.5 STORAGE

The composite drainage layer rolls delivered to the project site shall be stored in their original, unopened wrapping in a dry area and protected from precipitation and the direct heat of the sun. The materials shall be stored above the ground surface and beneath a roof or other protective covering.

1.6 QUALITY ASSURANCE

Quality assurance of geosynthetic installation shall be performed in accordance with the Construction Quality Assurance Procedure.

PART 2: PRODUCTS

2.1 GEONET

A. The geonet shall be a high density polyethylene (HDPE) material with intersecting material strands creating a three dimensional structure which supports planner water flow.

B. The geonet shall conform to the following requirements or the manufacturers minimum published values, whichever is more restrictive:

Properties	Test Method	Required Value
Transmissivity (M^2/S), min.	ASTM D4716 i = 1.0 Φ = 2000 psf	1.4×10^{-3}
Tensile Strength (lb/in), min.	ASTM D1682 or D4595	22

C. Contractor shall provide conformance testing as required by Construction Quality Assurance Plan.

2.2 PIPE

The pipe used within the perimeter cap drainage system (where required) shall be a six (6)-inch perforated corrugated polyethylene tubing (Class 2 Perforations) meeting the requirements of AASHTO M25-94. The pipe shall include all appropriate connections and end protection recommended by the manufacturer and as shown on the design drawings.

2.3 GEOTEXTILE

A. The geotextile bonded to the geonet shall be a non-woven material conforming to the following requirements. Geotextile shall be heat bonded to the geonet and extend a minimum distance of 6-inches beyond the geonet at either end of the cross machine direction.

Properties	Test Method	Required Value
Grab Strength (lbs.), min.	ASTM D4632	150
Puncture Strength (lbs.), min.	ASTM D4833	75
Tear Strength (lbs.), min.	ASTM D4533	70
Mass per Unit Area (oz/sy), min.	ASTM D3776	8
Apparent Opening (US sieve No.)	ASTM D4751	80
Ply Adhesion (lbs/in)	ASTM D413	1.0

B. The geotextile wrap used for the cap edge drains shall meet the same minimum requirements but will not be bonded to the geonet.

2.4 PEA GRAVEL FILL

Pea gravel fill shall be used as drainage material around the piping system for the perimeter cap drain and the cap edge drain. Granular fill shall be clean, rounded material with particles not larger than 1-1/2-inch in diameter and no greater than 5 percent fines (pea gravel).

2.5 INTERFACE FRICTION

Shear box testing shall be performed at confining pressures of 0.5, 1.5 and 3.0 psi. Shear box test results shall demonstrate that the composite drainage layer and geomembrane have the following values:

Cover Soil/geotextile of composite	22° min.
Geotextile of composite/textured geomembrane	22° min.
Textured geomembrane/geotextile	22° min.
Geotextile/soil	22° min.

Lower interface friction values may be approved by the Engineer if finished slopes on the Containment Cell are less than 3 horizontal:1 vertical.

PART 3: EXECUTION

3.1 GENERAL

A. The work shall be coordinated with placement of the HDPE geomembrane and anchor trench backfill. The cap drainage layer shall be placed directly above the HDPE geomembrane.

B. Prior to placement of the cap drainage layer, the portion of the geomembrane to be covered by the geonet/geotextile composite shall have all required documentation complete. The surface of the geomembrane shall not contain stones or excessive dust that could cause damage.

C. The composite drainage layer shall be cut, if necessary, using an approved cutter. Care must be taken to protect underlying geomembrane if the geonet or geotextile is being cut in place.

D. Equipment used to deploy the composite drainage layer shall not damage the materials or the underlying geomembrane.

3.2 COMPOSITE DRAINAGE LAYER

A. The Contractor shall keep the composite drainage layer clean and free from debris. Soils and debris shall be cleaned by the Contractor just prior to installation, as determined by QA Representative. The Contractor shall handle all rolls in a manner to ensure they are not damaged in any way. To prevent folds and wrinkles, tension should be kept on the materials. Materials shall not be placed across side slopes. Geotextile side of the composite shall be placed facing up.

B. In the presence of winds, the composite drainage layer shall be weighted with sandbags, as necessary. The Contractor shall be responsible for damage caused by wind.

C. Adjacent geonet rolls shall be overlapped at least 6-inches and secured by plastic ties approximately every three (3) feet along the roll length. Plastic ties shall be white or another bright color for easy inspection. Metallic ties shall not be allowed. The heads of the ties must fit completely into the geonet channel space so that the head of the tie does not intrude into or against the primary liner. Adjacent pieces of composite drainage layer shall have their top geotextile components lystered together after the geonet is connected and accepted by QA Representative.

D. Horizontal seams shall not be placed on side slopes greater than 5% unless approved by QA Representative in the panel placement plan.

E. Repair

Patching of the composite shall be used to repair holes, tears, and defects. Patches shall provide 6" of overlap around the repaired area and shall be held in place with plastic ties. Composite shall be removed if areas with large defects are observed. QA Representative shall determine the acceptability of the composite drainage layer.

3.3 DRAINAGE LAYER EDGE DRAIN

A. The six (6)-inch diameter perforated polyethylene pipe shall be placed in the anchor trench following placement of the cap geomembrane and geotextile wrap. The Contractor shall place the pipe in a manner which ensures underlying materials are not damaged. Edge drain shall be continuous with outfalls located no greater than 200 ft apart. Details of the pipe can be seen on Sheet 11.

B. Pea gravel fill shall be placed around the pipe for drainage. Pea gravel fill shall be placed by the Contractor in a manner which ensures surrounding materials are not damaged. Pea gravel fill shall be placed to provide proper support for the overlying trench backfill. The QA Representative shall monitor fill placement.

3.4 OUTFALLS

Cap drain outfalls shall be installed at the locations shown on Sheet 5 and in accordance with the detail on Sheet 11.

PART 4: MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Measurement for payment for the composite drainage layer will be based on the actual number of square yards of covered surface area in-place.

The cap drainage layer edge drain shall be measured as lineal feet in-place and shall include required granular fill, perforated pipe, pipe fittings, geotextile and cap drain outfalls.

Granular fill will not be measured and will be considered incidental to pipe placement.

4.2 PAYMENT

All prices shall include, but will not be limited to, submittals, testing, material manufacture, packaging, delivery, and storage; deployment, patches, seams, overlaps, repairs; and cleanup.

All work associated with furnishing and hauling material will not be paid separately but shall be included in the work required, or as approved by the Resident Engineer. No additional payment will be made for removing approved materials which are rendered unsuitable after placement or replacement or for removal, hauling, disposal and replacement of objectionable materials.

The completed work as measured for the cap drainage layer shall be paid for according to the unit price schedule.

PAY ITEM	PAY UNIT
Composite Drainage Layer	Square yard
Edge Drain (complete)	Linear foot
Edge Drain Outfall	Each

END OF SECTION

SECTION 02755

CAP BARRIER LAYER

PART 1: GENERAL

1.1 DESCRIPTION

The Work covered by this section includes furnishing the materials, equipment, labor and expertise required to supply, fabricate and install the high density polyethylene liner (HDPE) component of the containment cell cap barrier layer and the underlying non-woven geotextile.

1.2 RELATED SECTIONS

A. Section 01050 - Field Engineering

B. Section 01300 - Submittals

C. Section 01351 - Health and Safety Plan Requirements

D. Section 02210 - Earthwork

E. Section 02715 - Water Management During Construction

F. Section 02751 - Cap Drainage Layer

1.3 REFERENCES

ASTM D638 -	Test Method for Tensile Properties of Plastics
ASTM D746 -	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D792 -	Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D1004 -	Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D1204 -	Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
ASTM D1238 -	Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer

ASTM D1505 -	Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D1603 -	Test Method for Carbon Black in Olefin Plastics
ASTM D1682 -	Test Method for Strip Tensile Strength
ASTM D1693 -	Test Method for Environmental Stress Cracking of Ethylene Plastics
ASTM D2663 -	Test Method for Rubber Compounds-Dispersion of Carbon Black
ASTM D3015 -	Standard Practice for Microscopical Examination of Pigment Dispersion in Plastic Compounds (NSF Modified)
ASTM D4354 -	Standard Practice for Sampling of Geosynthetics for Testing
ASTM D4437 -	Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
ASTM D4533 -	Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D4595 -	Test Method for Tensile Properties of Geotextiles by Wide Width Strip Method
ASTM D4716 -	Test Method for Constant Head Hydraulic Transmissivity of Geotextiles and Geotextile Related Products
ASTM D4759 -	Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D4833 -	Test Method for Index Puncture of Geotextiles, Geomembranes and Related Products
ASTM D5084 -	Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter
ASTM D5321 -	Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method

GRI Test Method GM6 - Pressurized Air Channel Test for Dual Seamed Geomembranes
NSF Standard 54(1991) Flexible Membrane Liners

1.4 SUBMITTALS

A. Bid Submittal

The Manufacturer and Contractor shall submit proof of qualifications with bid documents. These Submittals shall include the following:

1. Manufacturer: The Manufacturer shall submit a Quality Control Manual, a list of material properties, and a list of completed facilities totaling 5,000,000 square feet (list should specify facility name, location, date of installation, owner name, designer, Contractor, as well as the name and telephone number of a contact at the facility who can discuss the project).

The manufacturer shall also provide a minimum ten (10) year material warranty.

2. Contractor: The Contractor shall submit certification that the Installation Supervisor and Master Seamer have reviewed the Construction Drawings, the Construction Quality Assurance Plan and these Specifications. The Contractor shall also submit a copy of the Manufacturer's approval letter or license, qualifications resumes for the Installation Supervisor and Master Seamer, proposed seaming method descriptions, detailed quality control procedures and a list of completed facilities totaling 1,000,000 square feet each of polyethylene geomembrane (list should specify facility name, location, Manufacturer, date of installation, designer, and the name and telephone number of a contact at the facility who can discuss the project).

B. Post-Contract Award Submittal

After the contract award, the geomembrane Contractor shall submit a Panel Layout Plan to the QA Representative for approval. This plan shall be submitted at least two weeks prior to delivery of the geomembrane to the site.

C. Interface Testing Submittal

The Contractor shall have an independent geosynthetics testing laboratory perform shear box testing pursuant to ASTM D5321 for the interfaces and confining pressures identified in Section 02751.

1.5 PRODUCT HANDLING

Transportation and handling of the geomembrane shall be the responsibility of the Contractor. The Contractor shall provide all necessary equipment and assure that personnel are properly trained for handling of the geomembrane. Geomembrane rolls shall be stored in an area which provides protection from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, or any other damage. Seriously damaged rolls, as determined by QA Representative, shall be rejected.

The geomembrane shall not be folded. Folded material shall be rejected.

1.6 QUALITY ASSURANCE

Quality assurance of geomembrane installation shall be performed in accordance with the enclosed Construction Quality Assurance Plan.

PART 2: PRODUCTS

2.1 RAW MATERIAL

The geomembrane shall be produced from raw materials, which may include the polymer resin, plasticizer, fillers, anti-degradants and processing aids. The resin used in production of the HDPE geomembrane shall meet the following requirements:

TEST	METHOD	REQUIREMENT	NOTES
SPECIFIC GRAVITY	ASTM D1505	>0.940	1 & 2
MELT INDEX	ASTM D1238	<0.4 g/10 min.	1 & 2 (Condition E Max)
CARBON BLACK CONTENT	ASTM D1603	2 to 3%	2

(1) Measure prior to adding carbon black.
(2) Test shall be performed at a rate of at least 1 per resin batch.

2.2 GEOMEMBRANE ROLLS

A. The geomembrane used at the site shall be a textured 60 mil high density polyethylene (HDPE). HDPE rolls shall meet the following requirements:

1. Condition: The geomembrane surface shall not have striations, roughness, pinholes, bubbles, staple marks, folds, or any other damage.

2. Properties: The geomembrane, as delivered to the site, shall meet the following physical and index property requirements or the manufacturer's minimum published values, whichever is more restrictive. Adherence to this requirement shall be made a condition of the material purchase order:

Required Material Properties of HDPE

Properties	Test Method	60 mil textured
Thickness (mils), max.	ASTM D1593	57
Density (g/cc), max.	ASTM D792 or D1505	0.940
Tensile Properties	ASTM D638-NSF Modified	
1. Strength at Yield (lb/in. width) min.		126
2. Strength at Break (lb/in width), min.		90
3. Elongation at Yield (percent), min.		12
4. Elongation at Break (percent), min.		100
Tear Resistance (lb), min.	ASTM D1004	39
Dimensional Stability	ASTM D1204	+/-2.0
(% change), max.	100°C, 1 hr	
Puncture Resistance (lbs)	ASTM D4833	72
Carbon Black Content (%), range	ASTM D1603	2.0-3.0
Carbon Black Dispersion	ASTM D3015-NSF Modified	A1, A2

* Values obtained from NSF International Standard 54 Flexible Membrane Liners

2.3 EXTRUDATE BEADS AND/OR ROD

All extrudate shall be compatible with the HDPE geomembrane specified. Extrudate shall be from the same Manufacturer and of the same resin type as the geomembrane rolls.

2.4 GEOTEXTILE

The geotextile to be placed beneath the geomembrane on top of the soil shall be a non-woven material conforming to the following requirements.

Properties	Test Method	Required Value
Grab Strength (lbs.), min.	ASTM D4632	200
Puncture Strength (lbs.), min.	ASTM D4833	100
Tear Strength (lbs.), min.	ASTM D4533	80
Mass per Unit Area (oz/sy), min.	ASTM D3776	8

PART 3: EXECUTION

3.1 PREPARATION

Contractor and QA Representative shall inspect the surface of the stabilized soil prior to placement of the geotextile. The surface shall be dry, and free of sharp stones or protruding objects. The surface have been roughed using raking or other methods acceptable to the QA Representative.

3.2 GEOMEMBRANE ROLL CONFORMANCE

The Contractor shall have an independent laboratory perform confirmatory testing of the HDPE geomembrane rolls. Test shall include density (ASTM D792 or D1505, thickness (ASTM D1593), tensile characteristics (ASTM D638-NSF Modified), tear resistance (ASTM D1004), dimensional stability (ASTM D1204) and carbon black content (ASTM D1603). A roll shall be considered a production unit and a shipment to the site shall be a lot. Conformance shall be determined in accordance with ASTM D4759 once for every 100,000 sf of material installed.

3.3 GEOMEMBRANE AND GEOTEXTILE PLACEMENT

A. Panel Layout

1. A field panel is the unit area of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of a roll cut in the field.

2. At least four (4) weeks prior to construction, the Contractor shall provide the QA Representative with drawings of the area to be covered showing the orientation of all geotextile and geomembrane panels (i.e., panel layout plan). In general, seams shall be oriented parallel to the slope, i.e., oriented along, not across, the slope. Whenever possible, horizontal seams shall be located not less than five (5) feet from the toe of slope. In corners and odd-shaped geometric locations, the number of field seams shall be minimized.

3. Each panel shall be given an "identification code" (numeric or alpha-numeric) consistent with the layout plan. This identification code shall be agreed upon by the Contractor and QA Representative. The code shall be as simple and logical as possible. Identification codes shall be used for all project records.

4. Each seam shall be given an identification code consistent with the layout plan. The seam identification system should differentiate between seam types, where possible. The seam identification system shall be compatible with the panel numbering system. The identification codes shall be used for all project records.

B. Panel Placement

1. QA Representative shall verify that panels are installed at the locations indicated in the Contractor's layout plan, as approved or modified.

2. Geotextile panels shall be installed from top of slope and adjoining panels shall be sewn together. Geotextile panels shall be installed one at a time and each panel shall be seamed immediately after its placement. Adjacent panels shall be overlapped a minimum of twelve (12) inches. The sewn seam shall consist of a prayer stitch with nylon thread. Geomembrane placement shall follow immediately behind geotextile deployment. QA Representative may allow placement of additional panels; however, all panels placed must be seamed and properly anchored by the end of the

day. The geotextile shall not be allowed to get wet. QA Representative shall record the roll number, identification code, location and date of installation for each geomembrane panel placed.

3. The Contractor shall advise the QA Representative and the RMC of any and every change in the schedule.

4. Geomembrane placement shall not proceed at an ambient temperature below 0°C (32°F) or above 40°C (104°F). Ambient temperature shall be measured approximately one (1) foot above the liner. Placement shall not be performed during any precipitation, in the presence of excessive moisture (e.g., fog, dew), in an area of ponded water, or in the presence of excessive winds. QA Representative shall be the sole judge as to whether or not placement conditions are acceptable. QA Representative shall also verify that the subgrade has not been damaged by adverse weather conditions.

C. Geosynthetic Handling - The Contractor shall assure the following during placement:

1. Any equipment or tools used shall not damage the geotextile or geomembrane by handling, trafficking, leakage of hydrocarbons, or other means.

2. No personnel working on the geotextile or geomembrane shall smoke, wear damaging shoes, or engage in other activities which could damage the materials.

3. The method used to unroll the materials shall not cause scratches, crimps, cracks, or breaks in the geomembrane and shall not damage the geotextile.

4. The method used to place the panels shall minimize wrinkles (especially differential wrinkles between adjacent panels). If warranted, intentional wrinkling of the geomembrane to compensate for expansion/contraction is allowable. Locations and dimensions of these wrinkles shall be detailed by the Contractor on the Geomembrane Layout Plan submitted to QA Representative.

5. Depressions in the compacted subgrade causing bridging by the geosynthetic cap components shall be removed or leveled by the Contractor.

6. Adequate temporary loading (e.g., sand bags) not likely to damage the geosynthetics shall be placed to prevent wind uplift.

7. Direct contact with the geomembrane shall be minimized; i.e., the geomembrane in traffic areas shall be protected by geotextiles, extra geomembrane, or other suitable materials approved by QA Representative.

D. Inspection of deployed panels:

1. QA Representative and Contractor shall inspect each panel for damage immediately after placement, but prior to seaming. Panels which are seriously damaged shall be rejected, while panels with minor damage may be allowed.

2. QA Representative shall be the sole judge as to whether panels are acceptable or must be removed. QA Representative shall record all damages and advise the Contractor as to which panels, or portions of panels, shall be rejected, repaired, or accepted.

3. Damaged panels or portions of damaged panels which have been rejected shall be marked and removed from the site by the Contractor at his own cost.

4. Repairs shall be made according to procedures described in this specification or according to Manufacturer's procedures, as approved by QA Representative.

E. Field Seaming

1. The Contractor shall ensure that adjacent panels of geomembrane are overlapped by a minimum of four (4) inches. Seams aligned across the slope shall be overlapped such that the upslope panel lies over the downslope panel.
2. Seam Preparation - Prior to seaming, the following procedures shall be followed:

   a. The seam area shall be clean and free of moisture, dust, dirt, debris of any kind, and foreign matter. Brush and wash the seam overlap portion of each panel as necessary to ensure clean contact between the panels.

b. Rolls must be laid out with no tension so that seams are aligned without wrinkles and "fishmouths".

c. For extrusion welding, grinding of the geomembrane shall be done with a hand held rotary grinder having 80 grit or finer sandpaper. Grinding shall be perpendicular, not parallel, to the seam. Overgrinding shall be avoided.

3. Weather Conditions - The following weather restrictions apply to seaming operations:

   a. Seaming shall not take place during any precipitation, in the presence of excessive moisture (i.e. fog, dew, frost), in an area of ponded water or in the presence of excessive winds (unless wind barriers are provided).

   b. Seaming may proceed if the geomembrane sheet temperature is above 32°F (0°C) if it can be proven via test strips that quality seams can be fabricated at lower temperatures. QA Representative shall determine the acceptability of cold weather seaming. A movable protective layer may be required below each seam overlap to prevent moisture buildup due to condensation during seaming.

   c. Seaming may proceed if the sheet temperature is above 122°F (50°C) if it can be proven via test strips that quality seams can be fabricated at higher temperatures. QA Representative shall determine the acceptability of hot weather seaming. Sheet temperature should be measured by an infrared thermometer or surface contact thermocouple.

4. Test seams shall be made each day by the Contractor prior to commencing field seaming. Test seams shall be performed for each seamer working that day. These seams shall be made on fragment pieces of geomembrane liner to verify that seaming conditions are acceptable. Such test seams shall be at startups and at least once every four hours, or at the discretion of QA Representative. A field tensiometer shall be used by the Contractor to determine the peel and shear of test seams in accordance with ASTM D4437-NSF modified for 5 peel and 5 shear coupons. QA Representative shall determine the acceptability of test seams. If test seams are determined to be inadequate, appropriate corrective actions shall be taken.

5. Geomembrane seaming shall be performed by extrusion welding, extrusion flat wedge welding and/or hot wedge welding.

3.4 TESTING

A. Non-Destructive Seam Continuity Testing

1. The Contractor shall non-destructively test all field seams over their full length. The purpose of this testing is to verify seam continuity. Testing shall be done as the seaming work progresses. In addition, the Contractor shall record location, date, seam number, name of tester, and outcome of all testing. QA Representative shall monitor non-destructive seam testing.

2. The Contractor shall complete any required repairs in accordance with this specification. If repairs are required, the Contractor shall mark on the geomembrane that the repair has been made and shall document the results of non-destructive testing on the repair.

3. The following procedures shall be implemented by the Contractor at locations where seams cannot be non-destructively tested:

   a. If the seam is accessible to testing equipment prior to final installation, the seam shall be non-destructively tested prior to final installation.

   b. If the seam cannot be tested prior to final installation, acceptable seaming and cap-stripping operations shall be agreed upon between QA Representative and Contractor regarding uniformity and completeness. All such seams shall be cap-stripped with the same geomembrane.

4. Non-destructive seam testing shall be performed using either a vacuum box in accordance with ASTM D4437 or pressurized dual seam testing as outlined by GRI Test Method GM6. Other non-destructive test methods may be used, as approved by QA Representative.

B. Destructive Seam Strength Testing

1. The Contractor shall have an independent laboratory destructively test field seam samples. The purpose of this testing is to verify seam integrity.

The Contractor shall provide QA Representative with verbal results within 48 hours after seam sampling.

2. The Contractor shall submit to QA Representative one destructive seam sample per 500 feet of seam length. The exact sample location shall be selected by QA Representative. Individual samples may be taken at greater or lesser intervals. Additional destructive samples may be taken, at the discretion of QA Representative, in areas of excess crystallinity, offset welds, areas of contamination, or other visible discontinuities.

3. The sample cut shall be eighteen (18) inches wide by thirty-six (36) inches long with the seam centered lengthwise. The sample shall be cut into thirds; one section for the Contractor and two sections for QA Representative. Samples shall be cut by the Contractor under the observation of QA Representative.

4. QA Representative shall be responsible for destructive testing to assure seam integrity. Seams shall be tested by an independent laboratory for shear strength and peel adhesion. The following properties shall be required of an acceptable seam:

TEST	TYPE OF BREAK	REQUIRED STRESS
Shear Strength	FTB greater than 100% elongation ASTM 4437-NSF Modified	100 lb/in, min.
Peel Adhesion	FTB less than 30% separation ASTM 4437-NSF Modified	75 lb/in, min. (Fusion)

5. Ten one (1)-inch wide replicate specimens shall be cut from the twelve (12)-inch wide sample. Five specimens shall be tested for shear strength and five for peel adhesion. All specimens must meet minimum strength requirements and at least four of the five samples for each test must fail outside of the seam area and meet the aforementioned requirements.

6. All holes in the geomembrane resulting from seam sampling shall be immediately repaired. Patches shall be vacuum tested to assure continuity.

7. The following procedures shall apply whenever a seam sample fails a destructive test. The Contractor has two options:

   a. Reconstruct the seam between the failed location and any passed test location.

   b. Retrace the welding patch to an intermediate location (at a minimum distance of ten (10)-feet from the failed test location) and take a eighteen (18)-inch by twelve (12)-inch sample for an additional destructive seam test. If this sample passes the destructive seam test, then the seam shall be reconstructed or cap stripped between the passed locations. If this sample fails, then the process shall be repeated.

   c. Cap strip the seam between the failed location and the closest adjacent passing test location.

   d. In any case, all acceptable reconstructed seams shall be bounded by two passed test locations (i.e., the above procedure shall be followed in both directions from the original failed location). For long lengths of reconstructed or cap stripped seam, QA Representative shall take additional destructive seam samples.

3.5 DEFECTS AND REPAIRS

A. All seams and non-seam areas of the geomembranes shall be evaluated by the Contractor and QA Representative for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane shall be clean at the time of inspection. The geomembrane surface shall be broomed or washed by the Contractor if the amount of dust or mud inhibits inspection.

B. Each suspect location in seam and non-seam areas shall be non-destructively tested using the methods detailed in this specification. Each location which fails non-destructive testing shall be marked and repaired by the Contractor. QA Representative shall verify markings and repairs.

C. Repair procedures are as follows:

   1. Defective seams shall be repaired by reseaming or applying a cap strip.

2. Tears or pinholes shall be repaired by extrusion welding or patching.

3. Blisters, larger holes, undispersed raw materials, and areas contaminated by foreign matter shall be repaired by patches.

4. Cap strips shall be at least six (6) inches wide and must be centered over the repair location. Cap strips shall be of the same material as the geomembrane.

5. Patches shall be round or oval in shape, made of the same materials as the geomembrane, and extend a minimum of six (6) inches beyond all edges of the defect. Patches shall be applied using extrusion fillet welding or other technique approved by QA Representative.

6. Repairs shall be numbered and logged by QA Representative and Contractor. Logging shall include repair type, welding machine used, welder, location, date of repair and details of non-destructive and/or destructive seam evaluation.

D. Each repair shall be evaluated using non-destructive testing, as described in this specification. Repairs which pass non-destructive testing shall be considered adequate. Repairs which fail non-destructive testing shall be redone and retested until a passing test is achieved. Destructive testing of long lengths of cap strips shall be performed as determined by QA Representative.

3.6 GEOMEMBRANE ACCEPTANCE

A. The Contractor shall retain all ownership and responsibility for the geomembrane until acceptance by RMC. The geomembrane shall be accepted by RMC when all of the following apply:

1. Geomembrane installation is finished.

2. All required documentation of installation is completed by the Contractor and QA Representative's certification report is completed.

3. Material conformance and destructive seam testing is completed.

4. Verification of the adequacy of all field seams and repairs, including associated testing, is completed.

5. The Contractor shall provide a final certification stating that installation has proceeded in accordance with the project specifications.

6. Written certification documents, including as-built drawings, sealed by a registered professional engineer have been received by RMC.

3.7 QUALITY ASSURANCE FOR CONTAINMENT CELL CAP SYSTEM

A. Raw Material (HDPE)

The geomembrane manufacturer is responsible for the production of geomembrane rolls from resin. Upon delivery, the following shall be furnished by the manufacturer:

1. The original resin supplier's name, resin production plant, identification (brand name/number), and productive date of the resin.

2. A copy of the quality control certificates issued by the resin supplier, noting results of density and melt index.

3. Reports on tests performed by the manufacturer to verify the quality of the resin used in the geomembrane and geonet rolls assigned to the RMC site meet the project specifications.

B. Product Certifications

The Contractor shall submit certification that all geomembrane, geotextile, and geonet rolls brought to the site meet the requirements of the specifications. For each material used at the site, the Contractor shall provide the following to QA Representative:

1. A properties sheet including specified properties and testing methods.

2. The base polymer descriptions.

3. Testing results and sample procedures from quality control testing.

4. A certification that property values given in the properties sheet are guaranteed by the manufacturer.

5. Statement certifying that no reclaimed polymer is added to the resin. Product run may be recycled, but shall only be at a proportion of 2 percent of the batch by weight.

6. Geosynthetic delivery, storage, and handling instructions.

One quality control certificate for every roll of geosynthetic used shall also be provided to QA Representative by the Contractor. This certificate shall include roll numbers and identification. The finished rolls shall be identified by a number corresponding to the particular batch of resin used. QA Representative will review all certificates for compliance with the project specifications.

The following information shall also be provided by the Contractor for any extrudate used for the project:

1. Statement of production date(s).

2. Certification stating that all extrudate is from the same manufacturer and is of the same resin type as the geomembrane seamed.

3. Copy of quality control certificates issued by the manufacturer.

C. Transportation and Handling

Geosynthetic rolls or panels shall be packaged and shipped by appropriate means so that no damage is caused.

The Contractor shall complete a Material Delivery Report (Form 1)

D. Subgrade Acceptance

1. Immediately prior to installation of the geotextile, the subbase surface shall be observed by QA Representative, Installer and Contractor. The decision to repair ruts or depressions, if any, shall be made by QA Representative. The Contractor shall repair any unacceptable subbase.

2. All recommendations and work performed on the subbase prior to installation shall be recorded. No geomembrane shall be placed on surfaces not previously found acceptable to QA Representative.

3. Surfaces to be lined shall be smooth, and free of debris, roots, and angular or sharp stones larger than 2-inch. The subbase surface shall be free from organics, trash, clayballs, sharp stones or any other deleterious material. The subbase shall be compacted in accordance with the design specifications but in no event below the minimum required to provide a firm unyielding foundation sufficient to permit the movement of vehicles and welding equipment over the subbase without causing rutting. The subbase shall have no sudden or abrupt changes in grade.

E. Anchor Trench

1. The anchor trench shall be excavated to the line, grade, and width shown on the construction drawings, prior to geosynthetic placement. The Contractor shall verify that the anchor trench has been constructed according to the project drawings.

2. The anchor trench shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled by the Contractor after installation of the geotextile, geomembrane, drainage layer and perforated polyethylene pipe, as outlined in the project specifications.

F. Geomembrane Installation

1. Immediately prior to installation of the geomembrane, QA Representative shall observe the geotextile surface to insure that it is smooth, dry and free of creases, lumps and foreign objects.

2. Welding shall not take place during any precipitation, in the presence of excessive moisture, i.e., fog, dew, frost, in an area of ponded water or in presence of excessive winds (unless wind barriers are provided).

3. Seaming may proceed if the geomembrane sheet temperature is above 32°F (0°C), or if it can be proven via test strips that good seams can be fabricated at lower temperatures. QA Representative shall determine the acceptability of cold weather seaming. Sheet temperature should be measured by an infrared thermometer or surface contact thermocouple.

4. The Contractor shall be responsible for the following:

a. No equipment or tools shall damage the membrane by handling, trafficking, or other means.

b. No personnel working on the lining system shall smoke, wear damaging shoes, or engage in other activities that could damage the geosynthetics.

c. The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil.

d. The method used to place geomembrane panels shall minimize wrinkles. Wrinkles shall be identified as to proper location by the Installer and shall be shown on the Contractor's As-Built drawings. Ballast shall be used to prevent relocation of the compensating wrinkles by wind.

e. Bridging shall be removed.

f. Adequate loading (i.e., sandbags) shall be placed to prevent uplift by wind. (In case of high winds, continuous loading is recommended along the edges of panels to minimize risk of wind flow under the panels).

g. Direct contact with the geomembrane shall be minimized, i.e., the geomembrane in traffic area is to be protected by geotextiles, extra geomembrane, or other materials approved by QA Representative.

5. A field panel is the unit area of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of a roll cut in the field. Each field panel shall be given an "identification code" consistent with the layout plan. This code should be as simple and logical as possible.

6. Field panels are installed at the locations indicated by the layout plan. Each panel placement should be recorded immediately using the daily deployment report. Identification code, location and date shall be recorded. Form 2, or a comparable equivalent, shall be used by the Contractor to evaluate panel thickness and as a record of daily deployment. All panels that are folded shall be replaced by the Installer.

7. Field Seaming

   a. The welding or seaming procedure consists of overlapping the two geomembrane sheets such that any water flowing across the seams would flow from the top panel to the underlying panel.

   b. Longitudinal seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. In corners and odd shaped geometric locations, the number of field seams should be minimized.

   c. Seams shall be aligned with the least possible number of wrinkles and "fishmouths". If a "fishmouth" or wrinkle is found, it shall be cut, removed and patched.

   d. Details of each seam, including seamer, machine number, time, and temperature shall be recorded by the Contractor on the Pre-Weld and Geomembrane Seaming Record (Form 3).

8. Pre-Weld/Trial Weld

   Pre-welds or trial welds shall be taken to verify the performance of welding equipment, seaming methods, and conditions. No seaming equipment or seamer shall be allowed to perform production welds until equipment and seamers have successfully completed trial weld(s). Pre-welds should be made in the same surroundings and environmental conditions as the production welds, i.e., in contact with the geotextile. Pre-welds shall be performed at the following frequency:

   a. At all start-ups and prior to planned shutdowns.

   b. Throughout the day as equipment requires start-up after a breakdown.

   c. At a minimum of 4 hour intervals or as directed by QA Representative.

9. Samples should be at least 2 feet long and 1 foot wide with the seam centered lengthwise. (Typically the samples are made by the welder seaming two pieces of the geomembrane together). Ten, 1-inch wide strips should be cut from the trial weld.

10. Specimens should be quantitatively tested for peel adhesion and for bonded seam strength (shear) using a recently calibrated field tensiometer. A specimen is considered to pass when the following results are achieved. (For double-wedge welding, both welds shall be tested and both shall be required to pass in peel).

    a. The break is film tearing bond (FTB).

    b. The break is ductile.

    c. The test results are consistent with test requirements established in paragraph 3.4(B) of Specification Section 02755.

11. Repeat the trial weld in its entirety when any of the trial weld samples fail in either peel and shear. When repeating trial welds fail, seaming apparatus and seamer shall not be used for production welding until deficiencies or conditions are corrected and two consecutive successful trial welds are achieved.

12. All trial welds shall be recorded by the Contractor on Form 3 (Pre-Weld and Geomembrane Seaming Record).

    a. Equipment - Extrusion fillet welders, extrusion flat wedge welders and hot wedge welders are the pieces of equipment approved for field seaming.

13. Non-Destructive Seam Testing

    Purpose of non-destructive testing is to check the continuity of the seam. The Contractor shall non-destructively test all field seams over their full length. All test equipment shall be furnished by the Contractor. Results of non-destructive testing shall be recorded on Form 4 non-destructive air pressure testing summary.

14. Destructive Seam Testing

    The purpose of destructive testing is to determine and evaluate seam integrity and assess long-term performance.

The Contractor shall provide a minimum of one destructive test sample per 500 feet of seam length from a location specified by QA Representative; individual samples may be taken at greater or lesser intervals.

Additional destructive tests may be taken in areas of contamination, offset welds, visible crystallinity or other potential cause of faulty welds, as determined by QA Representative.

All destructive seam samples shall be recorded by the Contractor on the Destructive Sample Record (Form 5). Information to be recorded includes date, sample number, seam number, machine number, seamer, date sent to lab and a summary of any field test performed.

a. Shear testing will be performed in accordance with ASTM D4437-NSF modified. This test involves peeling the sheets apart to observe how separation occurs. Results indicate whether or not the sheets are continuously and homogeneously connected through the seam.

b. Ten 1-inch wide replicate specimens shall be cut from the sample. Five specimens shall be tested for shear strength and five for peel adhesion. The test seam area will be considered acceptable if four of the five samples for each test fail outside of the seam area, provided all five samples must meet the following strength requirements:

SEAM PROPERTIES

TEST	TEST METHOD	FAILURE CRITERIA
Bonded Shear Strength (lb/in), min.	ASTM D 4437 - NSF Modified	100 (and Film Tear Bond) and >100% elongation
Seam Peel Adhesion (lb/in), min.	ASTM D 4437 - NSF Modified	90 (Fusion) and 75 (Fillet) Film Tear Bond and <30% Separation

Contractor shall document all actions taken in conjunction with destructive test failures.

15. Defects and Repairs

a. Identification - All seams and the entire geomembrane surface shall be inspected by the Contractor for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Unacceptable panels shall be removed and replaced. Because light reflected by the geomembrane helps detect defects, the surface of the geomembrane shall be clean at the time of observation. Reflecting light will cause the surface of the geomembrane, at locations where there are imperfections, to appear white or light in color. The geomembrane surface shall be brushed, blown, or washed by the Installer if the amount of dust or mud inhibits observation, as determined by QA Representative.

b. Evaluation - Any suspect locations shall be non-destructively tested as appropriate in the presence of QA Representative. Each location that fails the non-destructive testing shall be marked by the Contractor, and repaired accordingly.

c. Repair Procedures - Any portion of the geomembrane exhibiting a flaw or failing a destructive or non-destructive test shall be repaired.

1. Defective seams shall be restarted/reseamed as described in these specifications.

2. Small holes shall be repaired by extrusion welding. If the hole is larger than 1/4-inch, it shall be patched.

3. Long lengths of failed seams shall be cap stripped.

4. Tears shall be repaired by patching. Where the tear is on a slope or an area of stress and has a sharp end it must be rounded by cutting prior to patching.

5. Blisters, large holes, undispersed raw materials, and contamination by foreign matter shall be repaired by large patches.

6. Surfaces of the geomembrane which are to be patched shall be abraded, cleaned and extrusion welded.

7. Folds shall be removed or patched.

Patches shall be round or oval in shape, made of the same geomembrane, and extended a minimum of 6 inches beyond the edge of defects. All patches shall be the same compound and thickness as the geomembrane specified. All patches shall have their top edge beveled with a grinder prior to placement on the geomembrane. Patches shall be applied using approved methods only.

All surfaces must be clean and dry at the time of repairs. All seaming equipment used in repairs must be approved by QA Representative and Contractor. All repair procedures, materials, and techniques shall be approved in advance of the specific repairs by QA Representative and Contractor.

Form 6 (FML Repair Locations) shall be completed by the Contractor to document repairs.

a. Restart/Reseaming Procedures - The welding process shall restart by grinding the existing seam and rewelding a new seam. Welding shall commence where the grinding started and must overlap the previous seam by at least two inches. Reseaming over an existing seam without regrinding shall not be permitted. Reseaming must be approved by QA Representative.

b. Verification of Repairs - Each repair shall be non-destructively tested. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved. QA Representative shall take additional destructive seam samples, as necessary, for long lengths of cap stripped seam.

c. Recording of results: daily documentation of all non-destructive and destructive tests shall be prepared by QA Representative. This documentation shall identify all seams that initially fail destructive testing and indicate evidence that these seams were repaired and successfully retested. Documentation shall identify all patch, bead or cap strip locations and indicate that repairs were made and successfully tested.

PART 4: MEASUREMENT AND PAYMENT

4.1 MEASUREMENT

Measurement for payment of the geomembrane will be based on the actual number of square yards of covered surface area in-place.

4.2 PAYMENT

All prices shall include, but will not be limited to, submittals, testing, material manufacture, packaging, delivery, and storage; deployment, patches, seams, overlaps, repairs; and cleanup.

All work associated with furnishing and hauling material will not be paid separately but shall be included in the work required, or as approved by the Resident Engineer. No additional payment will be made for removing approved materials which are rendered unsuitable after placement or replacement or for removal, hauling, disposal and replacement of objectionable materials.

The completed work as measured for the cap barrier layer shall be paid for according to the unit price schedule.

PAY ITEM	UNIT
Geomembrane	Square Yard

FORM 1

MATERIAL

DELIVERY REPORT

PROJECT NAME:
PROJECT NUMBER:
LOCATION:
DATE:
MATERIAL TYPE:

ROLL NO.	BATCH NO.	RESIN TYPE	DESCRIPTION OF DAMAGE

COMMENTS:

OFF-LOADING PROCEDURES:

MATERIAL STORAGE:

FORM 2

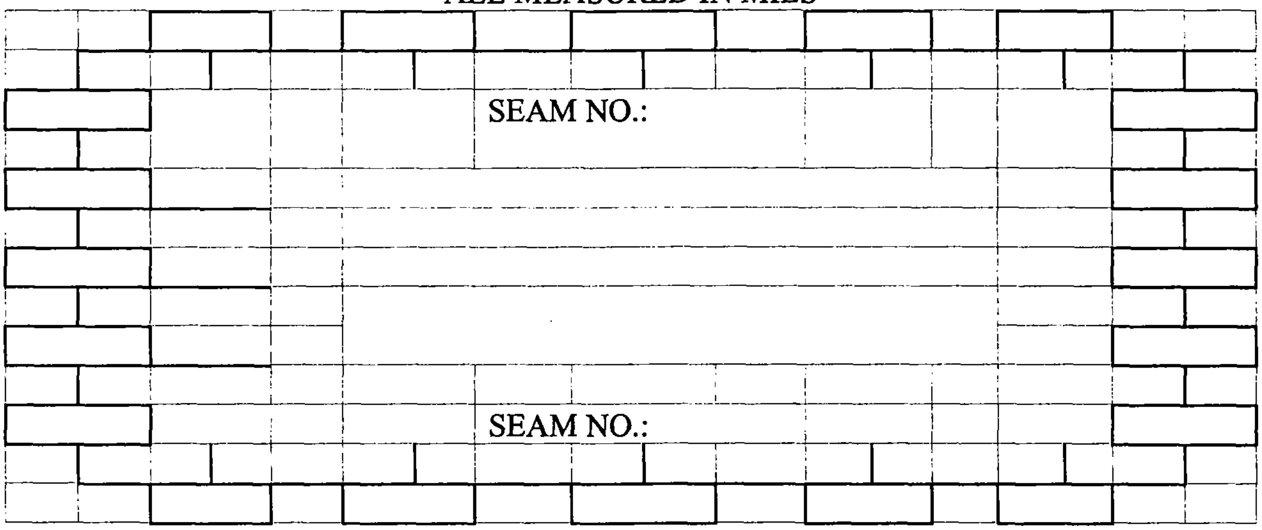
GEOMEMBRANE PANEL DEPLOYMENT LOG

PROJECT NAME:____________________ DATE DEPLOYED:

PROJECT NUMBER:__________________ TEMP: Max:________F; Min:________F

LOCATION:________________________ WIND:________________ mph N S E W

ALL MEASURED IN MILS



SUB-GRADE ACCEPTED FOR AREA BENEATH PANEL NUMBER:

__________ Yes __________ No

REMEDIAL WORK REQUIRED:

__________ Yes __________ No

TYPE OF WORK REQUIRED:

REMEDIAL WORK COMPLETED AND AREA ACCEPTED:

__________ Yes __________ No

COMMENTS:	

PANEL NUMBER:________________

PANEL LENGTH:________________

ROLL NUMBER:________________

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FORM 3

PRE-WELD AND GEOMEMBRANE SEAMING RECORD

PROJECT NAME:
PROJECT NUMBER:
LOCATION:
DATE:
CQA MONITOR:

WELDING MACHINE NUMBER:__________ WELDER'S NAME:

Pre-weld Seam #	Time am/pm	Temp.	Temperature of		Results		Pass/ Fail*
			Welder	Extrudate	Peel	Shear	

COMMENTS:

NOTE: USE ONLY ONE FORM PER WELDER.

* PASS OR FAIL RESULTS ARE FOR PRE-WELDS ONLY, TEST RESULTS FOR SEAMS ARE DOCUMENTED ON FORMS 4 AND 5.

FORM 4

NON-DESTRUCTIVE AIR PRESSURE SEAM TESTING

PROJECT NAME:
PROJECT NUMBER:
LOCATION:

SEAM NUMBER	CQA	TIME	PSI	DATE	TIME	PSI	PASS/ FAIL *

* REPAIRS OF FAILED SEAMS ARE DOCUMENTED ON FORM 5

** EXTRUSION WELDED

FORM 5
DESTRUCTIVE SAMPLE RECORD

PROJECT NAME:
PROJECT NUMBER:
LOCATION:

DATE	DS NO.	SEAM NO.	MACH NO.	OPER NAME	FIELD TEST		DATE TO LAB PKG SLIP NO. FEDEX/UPS
					PEEL	SHEAR	

FORM 6

FML REPAIR FORM

REPAIR DESIGNATION	DATE DAMAGE OBSERVED	DATE REPAIR CONDUCTED	SIZE	LOCATION OF REPAIR	REPAIRED TEST DATE	RESULT

END OF SECTION

ATTACHMENT D

Construction Quality Assurance Plan Replacement Pages

CONSTRUCTION QUALITY ASSURANCE PLAN
CORRECTIVE MEASURES IMPLEMENTATION
REFINED METALS CORPORATION
BEECH GROVE, INDIANA

Prepared For:

Refined Metals Corporation
Beech Grove, Indiana

Prepared By:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-18
October 6, 2010
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TABLE OF CONTENTS

LIST OF APPENDICES

1.0 OBJECTIVE

Quality Assurance is defined as a planned and systematic pattern of means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service. Quality Control is defined as those actions which provide a means to measure and regulate the characteristics of an item or service in accordance with contractual and regulatory requirements.

This Construction Quality Assurance Plan (CQAP) establishes the quality assurances procedures for implementation of the Corrective Measures (CM) Design at the former Refined Metals Corporation (RMC) facility in Beech Grove Indiana. The purpose of the CQAP is to ensure that the quality control objectives spelled out in the specifications are being met and that RMC receives a quality project that will serve its intended purpose with minimal maintenance. The activities involving quality assurance activities identified in this CQAP include the following:

- Erosion and sediment control
- Transportation of waste materials
- Dust control
- Demolition of remnant structures
- Surveying
- Soil and sediment remediation
- Earthwork
- Containment cell capping
- Restoration

2.0 RESPONSIBILITIES

Owner: Refined Metals Corporation Beech Grove (RMC).

Engineer: Advanced GeoServices Corp

Contractor: The party responsible for overall implementation of the CM Design including, but not limited to, site preparation, remediation, demolition, material handling and management, earthwork, earthwork, dust control and air sampling, water management, containment cell construction and capping, and site restoration. While portions of the work associated with implementation of the CM Design may be subcontracted by the Contractor, the Contractor is ultimately responsible for overall quality of the completed project and completion within the agreed upon schedule and budgetary amounts.

Manufacturer: The party responsible for the production and/or supplying of products and materials purchased from off-site vendors. This shall include, but not be limited to, everything from temporary controls, such as silt fence, to imported soil, aggregate and topsoil, to geosynthetic components within the containment cell cap. The Contractor is ultimately responsible for ensuring that the materials and products utilized for the project meet the requirements of the specifications and are installed in accordance with the requirements and intent of the CM Design, including this CQAP. If the Contractor wishes to propose an alternate product or material in lieu of a specified material or because the material is no longer available or inappropriate for actual field conditions, the Contractor shall notify the QA Representative and seek approval prior to delivery of such materials or products to the site.

Installer: The party responsible for field handling, transportation, storing, deploying, seaming, temporary restraining (against wind), and installation of the geosynthetic components of the containment cell cap. (In some cases, the Manufacturer and Installer or Contractor and Installer could be the same party). The Installer shall be retained by the Contractor as a subcontractor.

Quality Assurance (QA) Representative: The party retained by RMC and independent from the Contractor or any of the Contractor's subcontractors that is responsible for observing and documenting activities related to the quality assurance of the work and compliance with the requirements of the CM Design. The QA Representative will be on-site on a full-time basis and will maintain open lines of communication between the Contractor, RMC, the CM Design Engineer, regulatory representatives.

Quality Assurance Analytical Testing Laboratory: The party retained by QA Representative for the purpose of analyzing confirmatory samples and supplemental sampling of borrow source materials, crushed concrete or other analysis as deemed appropriate during the work.

Contractor's Analytical Testing Laboratory: The party retained by Contractor for the purpose of analyzing borrows source materials, air samples, crushed concrete or other analysis as deemed appropriate during the work. The QA Analytical Testing Laboratory and the Contractor's Analytical Testing Laboratory shall not be the same lab.

Geosynthetic Testing Laboratory: The party, independent from the Contractor, Manufacturer, and Installer, responsible for conducting tests on samples of the geomembrane field seams obtained at the site. Laboratory to be retained by Contractor or Installer and approved by RMC.

3.0 QUALIFICATIONS

General

Presented in this section are the minimum qualification requirements for the key organizations involved with the implementation of the CM Design. The minimum standards must be demonstrated for each of the major categories listed. Where the specific services will be performed by a subcontractor, the primary contractor must provide documentation of appropriate experience for all subcontractors proposed for the project. All personnel performing intrusive activities or working in areas of exposed contaminants shall have a minimum of 40-hours of safety training with a current 8-hour annual refresher in accordance with 29 CFR 1910.120.

QA Representative

The QA Representative shall be experienced in construction and remediation projects, shall possess strong written and verbal skills and have experience in material placement and compaction, earthwork activities, geosynthetic installation, environmental sampling and understand basic surveying techniques.

Contractor

The Contractor shall have experience in constructing projects of similar size and scope and shall have completed at least six projects involving the remediation of soil and sediment impacted by inorganic contaminants. All employees of the Contractor shall have a minimum of 40- hours of safety training with current 8-hour annual refresher in accordance with 29 CFR 1910.120, and required site training.

Installer

The Installer shall be licensed or approved to install the Manufacturer's geomembrane. The Installation Supervisor shall have installed or supervised the installation of a minimum of 5,000,000 square feet of High Density Polyethylene (HDPE) liner. The Master Seamer shall have installed a minimum of 5,000,000 square feet of HDPE experience. All other seamers shall have installed a minimum of 500,000 square feet of geomembrane. All employees of the Installer shall have a minimum of 40-hours of safety training with current 8-hour annual refresher in accordance with 29 CFR 1910.120.

4.0 INSPECTION ACTIVITIES

Erosion and Sediment Control

Prior to construction, the Contractor is required to submit manufacturer's information for silt fence, construction entrances, contaminant reduction zones and related erosion and sediment control materials as described in Specification Section 02115. The QA representative shall review the Contractor's submittals for compliance with the requirements of the Specifications and CM design.

The erosion and sediment controls provide protection against the transport of potentially contaminated sediment from the active remediation area and protection against the transport sediment from those areas not designated for remediation and those areas where remediation has been completed. During execution, the QA Representative shall ensure that erosion and sediment controls are installed as required to prevent the migration of sediment laden water (contaminated or uncontaminated) and that water from areas designated for remediation do not cross-contaminate clean areas. The review will evaluate actual site conditions against the requirements for erosion and sediment control measure as depicted on Sheet 4 of the design drawings and may adjust the proposed location, amount and type of control to fit actual conditions. The review will be conducted in cooperation with the Contractor and with input from the CM Engineer as appropriate.

As work progresses site conditions will likely change and the integrity of the silt fence may degrade because of siltation, damage or general disturbance. The QA Representative will evaluate the adequacy of installed erosion and sediment measures at a minimum on a daily basis, after each runoff producing precipitation event and when the active work zone progresses. The QA representative shall ensure that the Contractor removes accumulated sediment from erosion and sediment control measures protecting active remediation areas prior to approving restoration of the remediation areas.

Transportation of Waste Materials

Truck loading will be monitored to help prevent trucks from being overloaded, although ultimately it will be the drivers and Contractor's responsibility to be certain trucks are not overloaded. Prior to leaving the loading area the bed of each hauling unit will be covered with a closely woven net tarp or canvass tarp to prevent the escape of windblown soil during transportation to the disposal facility. Each truck will be decontaminated in the Contamination Reduction Zone (CRZ) as required to prevent the off-site migration of contaminated materials. The loading area will be maintained in a clean manner, spilled material will be cleaned up as necessary. The designated truck route to the selected disposal facility will be presented to each truck driver prior to leaving the site.

Each load of waste material destined for off-site disposal (demolition debris not approved for placement in the Containment Cell) will be transported under a properly executed Bill of Lading or Hazardous Waste Manifest, as appropriate and as required by Specification Section 01355. Each bill of lading or manifest will be numbered sequentially to allow the number of loads hauled from the site to be tracked.

The QA Representative will be responsible ensuring that RMC has approved the proposed disposal or recycling destination and waste profiles have been signed by RMC and approved by the destination facility. The QA representative shall record in his fieldbook when shipments are sent off-site, the classification of the waste (hazardous versus non-hazardous), and the destination facility. The QA representative shall track that proof of disposal and disposal weight for each shipment has been received from the Contractor.

Dust Control and Air Monitoring

It is the intent of RMC to have the Contractor perform proposed CM construction activities in a manner capable of achieving the National Ambient Air Quality Standards (NAAQS) for lead. Specification Section 02999 provides the dust control and air monitoring requirements. As shown, the Contractor is responsible for providing real-time and time-integrated air sampling. The QA Representative shall review Contractor submittals for proposed sampling equipment, analytical laboratory, sampling station/platform configuration, and qualification of Contractor personnel. The locations for the proposed time-integrated samplers (TSP and total lead samplers) shall be situated as shown on Sheet 4 of the design drawings and may only be changed with consensus approval of RMC, USEPA, IDEM and CM Engineer.

The Contractor will be required to provide real-time monitoring around the perimeter of the active remediation zone. The QA representative will calculate an allowable Trigger Level for the real-time active work zones utilizing the average lead concentration for the area being remediated and a target maximum lead in air concentration of 0.15 µg/m3.

An example calculation would be as follows:

Average lead concentration of soil being remediated = 2,000 mg/kg = 0.002 mg/mg
Target Maximum lead in air concentration = 0.15 µg/m3

Trigger Level = (0.15 µg/m3)/0.002 mg/mg = 75 µg/m3

The Trigger Level represents a conservative value to utilize as a real-time measure for dust control. During execution it is possible that the Contractor may not be able to meet the calculated value when working in a very high concentration area. When an exceedance occurs; the Contractor shall temporarily stop work, review site conditions with the QA Representative, identify alternate/additional measures and implement the agreed upon measures before continuing work. If the area continues to exceed the Trigger Level the determination to allow continued work will be made based by the QA Representative in consultation with RMC. Short-term periods when a Trigger Level is exceeded will not be considered a failure of the dust control standards, but regular or protracted exceedances will not be permitted.

During execution of the work, the QA representative will review periodically throughout each work day the location and level of protection being provided by the Contractor. The QA Representative will obtain information regarding the wind direction and wind speed periodically during the day and record the information in the fieldbook. In addition, the Contractor is required to submit daily records with the Daily Report. The QA representative will consider wind speed and direction when evaluating the adequacy of dust control measures. Under high wind or extreme dry conditions it may be necessary for the Contractor to suspend work.

The QA Representative shall ensure that the methods and means being utilized for dust control are adequate for the site conditions and activities. The QA Representative shall have the authority to stop the work if he/she believes that the dust control procedures being utilized are inadequate. Adequacy of dust controls will be determind based on visual observations, real-time air monitoring, and laboratory TSP and lead results for the high volume air monitors.

Demolition of Remnant Structures

The QA representative shall review the Contractor's schedule, techniques and proposed limits for the required demolition and confirm that the work is coordinated with other work activities, that the techniques are appropriate for the nature of the demolition and the limits are consistent with the CM Design.

Surveying

The QA Representative shall review the approach to surveying proposed by the Contractor's Surveyor for technical approach and consistency with the CM Design. Specific attention will be given to the proposed grid system and cross-sections and establishment of bench marks. The elevation of each grid shall be surveyed prior to excavation or demolition and the system utilized must be reproducible to allow the documentation of removal depths relative to starting elevations and the adequacy of restoration. This data will be compared with the site characterization previously performed to insure that the depth of excavation is adequate. The Contractor is permitted to monitor removal depths using his own equipment provided that the monitoring is tied to within 1.0 feet of the originally established grid and cross-sections and accurate to within 0.1 feet vertically.

Soil and Sediment Remediation

The Surveyor will stakeout the horizontal limits of the removal areas, and the QA Representative and Contractor shall review the staked limits for consistency with the design and actual field conditions. Discrepancies or concerns should be raised with the Engineer prior to the start of excavation in the subject area. The QA Representative shall review the Contractor's protocol and controls for establishing removal limits.

The QA Representative shall confirm that affected soil and sediments are placed in the Containment Cell in accordance with following performance criteria indentified in the CM Design.

The QA Representative shall confirm that:

- Property Owner approvals have been received.
- Water management features have been established prior to the start of removal.

- The limits of initial excavation have been clearly marked and the existing elevations have been documented prior to the start of work.
- Excavations are conducted using methods approved by the QA Representative which prevent transport of sediments and minimize generation of water.
- Excavation sequencing is conducted as proposed by the Contractor and approved by QA Representative and RMC.
- Excavations have extended only to the limits marked, unless analytical data collected by the QA Representative confirms that additional excavation is necessary.
- The Contractor is employing measures to prevent contamination of soils not indicated for excavation.
- The excavation depth has extended to the depths identified in the CM Design (+/- 3-inches) or as directed by the QA Representative based on the previous sampling results.
- Confirmatory sampling has been conducted by the QA Representative.
- All visible waste materials (slag and battery casings) have been removed to the satisfaction of the QA Representative.
- Measures are employed to minimize the amount of water generated during construction. Water removed from within the excavation is contained and treated.
- Excavations are conducted to obtain the performance standards identified in the CM Design.
- Excavated materials are transported directly to the containment cell for placement.
- Materials being placed in the containment cell are placed in 12 inch loose lifts and are being compacted in a manner to create a stable surface capable of supporting the final cap.
- Material is placed in the containment cell using the sequencing proposed by the Contractor and approved by the QA Representative.
- The maximum material size is 12 inches in the longest direction.

- The top 6 inches of material are remediated soils with a maximum particle size of 2-inches.
- Cleared and grubbed materials not shipped off-site or approved for use elsewhere on-site is ground (<3 inches in longest dimension) and placed in a single 4 inch thick maximum lift.

Sampling and Analysis

The QA Representative will ensure that the confirmatory sampling discussed in the CM Design and the SAP included as part of this CQAP are followed.

Earthwork

Imported topsoil and/or fill shall be tested for compliance with the specifications prior to delivery to the site. Topsoil placement shall be monitored to ensure that it has been graded to promote drainage and prevent ponding and that it has been placed to the elevations specified. Topsoil materials whether placed for turf establishment or placed to sustain sod shall be fertilized and amended as recommended based on the agronomy testing required by the Specifications.

The QA Representative shall monitor the placement and compaction of on-site fill materials to insure that it is being placed and adequately compacted to prevent future settlement and promote positive drainage. The QA representative shall receive and review copies of the geotechnical laboratory and field density testing performed by the Contractor's QC representative.

<u>Containment Cell Capping</u>

The QA Representative shall review and discuss the Contractors proposed approach (construction sequence and construction techniques) for capping the containment cell. To the extent possible, installation of the geomembrane shall be completed as soon as possible after the final tops of waste elevations are achieved. If the time between achieving final grades and geomembrane installation will be greater than one week, the Contractor shall be required to protect the completed surface using temporary plastic sheeting placed in such a manner to shed precipitation and prevent direct contact of precipitation with the contaminated soils.

The 18-inch thick cover soil layer shall be placed as a single lift and construction equipment (except small rubber tired ATVs utilized by the Installer during geosynthetic deployment) will not be permitted on to the areas of the completed geomembrane installation until the cover soil layer is in-place. QA Representative shall ensure that all required inspections and documentation of the liner installation activities is completed prior to soil placement.

Topsoil will be submitted to a soils laboratory for analysis to insure that the topsoil is amended with the proper amount of fertilizer and agricultural lime. Seed and fertilizer shall be selected and applied as recommended by the local USDA Soil Conservation Office. Seed variety will be selected based upon the time of year the planting is to be completed and to insure a viable stand of grass is established that will require a minimum amount of maintenance. Seed shall be state-certified seed of the latest season's crop.

5.0 SAMPLING REQUIREMENTS

The QA Representative shall report the analytical results for post-excavation sampling, with appropriate sample identification and location, to RMC and Contractor within 24 hours of receiving the results from the laboratory.

The QA Representative in consultation with RMC and the Contractor, will determine the limits and extent of further excavation based upon the results of the sample analysis. RMC and its representatives may request additional samples for analysis to assist in the determination. Excavation and confirmatory sampling will continue until the performance criteria have been met.

The QA Representative shall ensure that:

- Sampling is conducted at the frequency indicated in the Appendix A.
- Post-excavation samples within HWMUs are analyzed for total lead, arsenic, antimony, cadmium and selenium. Post-excavation samples outside of HWMUs are analyzed for total lead.
- Performance standards are as indicated in the Specifications.

6.0 DOCUMENTATION

An effective CQAP depends largely on recognition of all construction activities that should be monitored, and on assigning responsibilities for the monitoring of each activity. This is most effectively accomplished and verified by the documentation of Quality Assurance activities. The QA Representative will document that the Quality Assurance requirements have been addressed and satisfied.

Following review, the QA Representative will provide the RMC with signed descriptive remarks, data sheets, and logs to verify that the monitoring activities have been carried out in accordance with the CQAP and that performance standards established in the CM Design Report have been achieved. The Contractor will maintain at the Site a complete file of the CM Design Report, Drawings and Specifications, CQAP, checklists, test procedures, daily logs, and other pertinent documents.

Daily Recordkeeping

The QA Representative's standard reporting procedures will include preparation of a weekly CQA report which, at a minimum, will consist of:

- a discussion of Site activities, including CQC testing, performed during the week;
- CQA and regulatory personnel and visitors present at the Site;
- field notes, including memoranda of meetings and/or discussions with participating parties or regulatory authorities;
- CQA monitoring logs and testing data sheets;
- construction problem and solution summary sheets;
- submittal status;
- date and weather conditions; and,

- signature of the QA Representative.

This information will be regularly submitted to and reviewed by RMC.

Monitoring Logs and Test Data Sheets

CQC monitoring logs and test data sheets will be prepared daily by the Contractor. When QA testing is performed, related monitoring logs and test data sheets shall be completed by the QA Representative for that work. At a minimum, these logs and data sheets will include the following information:

- an identifying sheet number for cross referencing and document control;
- date, project name, location, and other identification;
- data on weather conditions;
- descriptions and locations of ongoing construction;
- equipment and personnel in each work area, including subcontractors;
- descriptions and specific locations of areas, or units, of work being tested and/or observed and documented;
- locations where tests and samples were taken;
- a summary of test results;
- calibrations or recalibrations of test equipment, and actions taken as a result of recalibration;
- delivery schedule of off-site materials received, including Quality Control documentation;
- decisions made regarding acceptance of units of work, and/or removal activities to be taken in instances of substandard quality; and,
- signature.

RMC will be made aware of any significant recurring non-conformance with the Specifications. The Engineer will review the issues with the QA Representative to determine the cause of the non-conformance and recommend appropriate changes in procedures or Specifications. These changes will be submitted to the IDEM and the USEPA, as appropriate.

A summary of the supporting data sheets, along with final testing results and the QA Representative's approval of the work, will be required upon completion of construction.

Photographic Documentation

Photographs will be taken by the Contractor in order to serve as a pictorial record of work progress, problems, and removal activities. The basic file will contain color prints, labeled with the date, and subject of the photograph. These records will be presented to RMC upon completion of the project. Photographic reporting data sheets, where used, will be cross-referenced with observation and testing data sheet(s), and/or construction problem and solution data sheet(s). The Contractor will allow the RMC representatives to examine photographs at the Site, upon request.

Corrective Measures Design Plan and/or Specification Changes

The CMD and/or Specifications changes may be required during construction. In such cases, the Contractor will notify RMC and QA Representative when a change is believed to be warranted. Changes will be made only with the written agreement of the Engineer (following review and consultation with QA Representative, IDEM and USEPA, if necessary), and will take the form of an addendum to the Specifications.

Signatures and Final Report

At the completion of the work, the QA Representative will submit to RMC signed and sealed Final Reports. These reports will include an appropriate certification statement and will certify: (i) that the work has been performed in compliance with the CMD; (ii) physical sampling and testing, except as properly authorized, have been conducted at the appropriate frequencies; and (iii) that the summary document provides the necessary supporting information.

At a minimum, this report will include: (i) summaries of all construction activities; (ii) testing data sheets including sample location plans; (iii) construction problems and solutions data sheets; (iv) changes from design and Specifications; (v) record (as-built) drawings (to be provided by the Contractor); and (vi) a summary statement sealed and signed by a Professional Engineer registered in the State of Indiana.

The as-built drawings provided by the Contractor will include scale drawings depicting the location of the construction and details pertaining to the extent of construction (e.g. depths, plan dimensions, elevations, etc.). All surveying and base maps required for development of the record drawings will be prepared by the Contractor's qualified licensed land surveyor.

The documentation and information to be collected by the QA Representative from the Contractor for use in development of the Final Report shall include the following:

- Surveyor qualifications, including proof of Health and Safety training;
- Geomembrane Manufacturer qualifications;
- Geomembrane Installer qualifications;
- Other subcontractor qualifications;
- Contractor's Health and Safety Plan;

- Project record (as-built) drawings as required by Specification Section 01050;
- Restoration summary;
- Permits obtained by Contractor or Owner;
- Representative photographs;
- Validated soil sampling results including laboratory reports;
- If used, off-site disposal completed manifests, weight tickets, and certificates of disposal;
- Compaction test results;
- QC certificates for each roll of geosynthetic;
- Geomembrane panel layout plans;
- Installer's geomembrane certification;
- Destructive seam sample test results;
- Shear box test results;
- Quality Assurance monitoring logs and test data sheets;
- Material properties for:

    - Silt fence, and other erosion and sediment control devices;
    - CRZ and construction entrance aggregate and geotextile;
    - Water treatment system and procedures;
    - Cap geomembrane;
    - Geocomposite;
    - Aggregate and piping for cap anchor trench and outfalls;
    - Cover soil;
    - Topsoil and erosion control mat;
    - Seed, mulch and fertilizer;
    - Stormwater system piping, outlet structures and other features;
    - Fencing;

- Asphaltic Concrete Paving;
- Other site materials.

- Delivery tickets and/or certificates of compliance for all materials;
- Completed submittal register and approved submittals; and,
- Any other information needed for documentation of work in accordance with the Contract Documents.

Storage of Records

During performance of remediation activities, all records, including handwritten data sheet originals (especially those containing signatures), should be stored by the Contractor or his designee in a safe on-site repository. Other reports may be stored by a standard method which will allow for easy access.

APPENDIX A

CONFIRMATORY SAMPLING

Final CM Design
CQAP Appendix A
Refined Metals Corporation
Beech Grove, Indiana
March 21, 2011

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1.0 INTRODUCTION

1.1 GENERAL

As presented in Section 5.0 "Statement of Basis" of the Corrective Measures Design Report (Design Report), the proposed remedial activities within the horizontal limits of the former Hazardous Waste Management Units (HWMUs) shall be performed as Closure under the purview of the Indiana Department of Environmental Management (IDEM), while remediation on the remainder of the site and off-site are being performed as part of Corrective Measures under the purview of the United States Environmental Protection Agency (USEPA). Therefore, multiple remediation standards are being applied to the site. The soil standards, as discussed to greater detail in Section 5.0 of the Design Report are as follows.

1.2 CORRECTIVE MEASURES (ON-SITE AND OFF-SITE)

1.2.1 On-Site

Soil and sediment remediation on the former RMC property (outside the footprint of the HWMUs) and off-site are dictated specifically by lead. The standard for on-site for soil and sediment (outside the limits of the HWMUs) is 920 mg/kg, which corresponds to the Preliminary Remediation Goal (PRG) calculated through a site specific Baseline Human Health Risk Assessment (BHHRA) presented in and approved as part of the Corrective Measures Study (Advanced GeoServices August 6, 2007). The PRG represents the maximum allowable average concentration within a defined exposure area for the depth intervals considered in the BHHRA. For this project there are two exposure areas referred to as the "on-site exposure area" and the "grassy exposure area" (see Design Report, Figure 2) and the depth increments ("exposure depth") are 0-5 feet and 0-2.5 feet respectively.

1.2.2 Off-Site

As shown on Sheets 7 and 8, the proposed off-site excavation areas coincide with drainage ditches and swales that received surface water runoff from the facility. Sampling conducted as part of the RFI identified elevated concentrations of lead in the sediment and soil within these features. The lead remediation value for sediment and soil within these generally accessible Off-Site Areas is 400 mg/kg. The proposed soil and sediment removal is limited to the bottoms of the drainage features where concentrated surface water runoff has resulted in a lead concentrations >400 mg/kg. Within the less clearly defined drainage swale along South Arlington Avenue, the proposed excavation activities will extend from the site security fence to the edge of pavement for the road.

1.3 HAZARDOUS WASTE MANAGEMENT UNIT CLOSURE

Soil remediation within the limits of the former HWMUs is dictated by lead, as well as antimony, arsenic, cadmium and selenium. The soil remediation standards are shown below. The standards come from the IDEM RISC Industrial Closure Levels, Table A (antimony, arsenic, cadmium and selenium), while the value for lead represents the IDEM RISC Industrial Closure Levels for Construction.

Hazardous Waste Management Units (HWMUs)

Parameter	Soil Standard
Antimony	37 mg/kg
Arsenic	20 mg/kg
Cadmium	77 mg/kg
Lead	970 mg/kg
Selenium	53 mg/kg

As discussed in Section 5.0 of the Design Report, the values for lead and arsenic were justified based on site specific SPLP testing which demonstrated average partitioning coefficients more than an order of magnitude greater than the values utilized to calculate the IDEM RISC default Migration to Groundwater values.

2.0 CONFIRMATORY SAMPLING REQUIREMENTS

2.1 RMC PROPERTY (EXCLUDING HWMUs)

The removal limits shown on Sheet 7 of the design drawings have been selected to remove the highest concentration soils within each exposure area as necessary to achieve an average soil lead concentration (PRG) within the BHHRA exposure depth (0 to 5 feet within the On-Site Exposure Area and 0 to 2.5 feet within the Grassy Exposure Area) equal to or less than 920 mg/kg. It is also the intention of RMC that the remaining soil lead concentration at the bottom of each removal area on the RMC property be less than 920 mg/kg as determined through post excavation sampling at the bottom of the excavation area.

No excavation sidewall sampling or sampling beyond the horizontal limits of the excavation is required. Bottom confirmatory samples will be performed by the QA Representative utilizing an XRF with a minimum 20 percent of the samples sent off-site for laboratory analysis. The number of locations screened on the bottom of the excavations will be determined by the area of each excavation and will follow IDEM standard guidance for post-excavation sampling set forth in the IDEM RISC Technical Guide. The number of bottom samples required within each excavation area is listed on the table presented on Sheet 7 of the design drawings. A 10 foot by 10 foot grid will be superimposed over each excavation area. Each grid node will be assigned a unique identification number. A random number generator will be used to select the node numbers that will be sampled for XRF analysis. If a node is located at an inaccessible location, the next randomly selected node number will be sampled.

Samples for XRF analysis will be collected utilizing decontaminated or disposable sampling equipment from a depth interval of 0-6 inches. The samples will be placed into separate clean plastic baggies and homogenized by hand (protected by a clean glove) for approximately 1 minute. After homogenization, the XRF will be utilized to analyze the sample for lead in accordance with the USEPA's SW-846, Method 6200. Five readings will be taken from each sample and recorded in the fieldbook and the results averaged to provide the uncorrected representative concentration.

A minimum of 20 percent of the soil samples will be submitted to the Quality Assurance Analytical Laboratory for total lead analysis (Method 6010B). The samples for laboratory analysis will be selected between 150 and 1,200 mg/kg total lead to determine a correction factor that is most applicable at the PRGs.

The laboratory results will be evaluated against the corresponding average XRF concentration and a correction factor (regression equation) coefficient of determination (r^2). A minimum of 10 samples will be used to determine the correction factor. The (XRF) data will be considered suitable for use if the $r^2 \geq 0.70$ ($r = 0.837$). The correction factor will be applied to those XRF sample results without a corresponding laboratory result. If the corrected average is less than 920 mg/kg then the excavation area will be deemed complete. If the corrected average is greater than 920 mg/kg then additional excavation will be performed within portions of the excavation area as designated by the QA Representative. The amount of additional removal will be determined by the QA Representative based on the observed sampling results and visual conditions within the excavation. After re-excavation the remediated portions will be resampled at locations approximating the locations of the previous samples and analyzed with the XRF following the same protocol described above. The average XRF result will be corrected using the correction factor. This process shall be repeated until acceptable results are achieved.

If distinct layers or pockets of slag or battery casing materials are observed in the bottom or sidewalls of the excavation area, the QA Representative will require selective removal of the identified material.

2.2 OFF-SITE

The removal depths shown on Sheet 8 of the design drawings have been selected to remove the soil and sediment materials which exceed 400 mg/kg. No sidewall sampling or sampling beyond the horizontal limits of the proposed excavation is required, except along the southern limit of excavations areas AMT-1, 2 and 3. Completeness of the vertical removal, and southern limit of excavation areas AMT-1, 2 and 3, will be determined using the XRF with 20% laboratory confirmation as described in Section 2.1. The number of locations screened on the bottom of the excavations will be determined by the area of each excavation and will follow IDEM standard guidance for post-excavation sampling set forth in the IDEM RISC Technical Guide. The number of bottom samples required within each excavation area is listed on table presented on Sheet 8 of the design drawings. A 10 foot by 10 foot grid will be superimposed over each excavation area. Each grid node will be assigned a unique identification number. A random number generator will be used to select the node numbers that will be sampled for XRF analysis. If a node is located at an inaccessible location, the next randomly selected node number will be sampled. Samples for XRF analysis will be collected utilizing decontaminated or disposable sampling equipment from a depth interval of 0-6 inches.

Sidewall samples shall be collected at a minimum frequency of once every 20 feet of side wall, but no less than 3 measurements will be taken in any excavation. Where sidewalls exhibit distinct horizons as determined by the QA Representative based on soil texture, color and structure, sidewall sampling shall be performed separately for each horizon. Side wall samples shall be collected across a 6-inch increment for the horizon represented by the sample.

The samples will be placed into separate clean plastic baggies and homogenized by hand (protected by a clean glove) for approximately 1 minute. After homogenization, the XRF will be utilized to analyze the sample for lead in accordance with the USEPA's SW-846, Method 6200. Five readings will be taken from each sample and recorded in the fieldbook.

Results of the XRF analysis within each excavation area will be averaged, and adjusted utilizing a correction factor as discussed in Section 2.1. The corrected average will be compared against 400 mg/kg. If the average exceeds 400 mg/kg, then additional removal will be required. The amount of additional removal will be determined by the QA Representative based on the observed sampling results. Following additional removal, the confirmatory sampling process will be repeated for those areas subject to additional removal at locations approximating the previous confirmatory sample location. In addition, if distinct layers or pockets of slag or battery casing materials are observed in the bottom or sidewalls of the excavation area, the QA Representative will require selective removal of the identified material.

2.3 HAZARDOUS WASTE MANAGEMENT UNITS

The proposed removal depths shown within the former HWMUs have been established based on the results of the soil sampling. Horizontal limits have been defined based on the regulatory limits (e.g. edge of the HWMU) and physical limits (such as building walls) of the units. Where the boundary of a proposed excavation area is not defined by a regulatory or physical limit, the area has been delineated based on professional judgment and interpretation relative to surrounding results.

The HWMUs are being clean-closed to the soil contaminant levels listed above, following the general procedures established in the IDEM RISC Program. In accordance with those requirements, confirmatory samples must be collected from the bottoms and sidewalls of the excavations.

The number of locations screened on the bottom of the excavations will be determined by the area of each excavation and will follow IDEM standard guidance for post-excavation sampling set forth in the IDEM RISC Technical Guide. The area of each excavation and number of screening locations is provided on Sheet 6 of the design drawings. A 10 foot by 10 foot grid will be superimposed over each excavation area. Each grid node will be assigned a unique identification number. A random number generator will be used to select the node numbers that will be sampled for XRF analysis. If a node is located at an inaccessible location, the next randomly selected node number will be sampled.

Sidewall screening will also be performed in all HWMU excavations according to IDEM guidance documents, by performing screening every 20 feet. However, no screening will be performed on sidewalls that terminate at the regulatory limit of the HWMUs or on HWMU sidewalls that are scheduled to be excavated deeper than the exposed sidewall in question. The numbers of sidewall screening locations for each HWMU are shown on Sheet 6.

Samples for XRF analysis will be collected utilizing decontaminated or disposable sampling equipment from a depth interval of 0-6 inches below the bottom of the excavation. The samples will be placed into separate clean plastic baggies and homogenized by hand (protected by a clean glove) for approximately 1 minute. After homogenization the XRF will be utilized to analyze the sample for lead, arsenic, antimony, cadmium and selenium, in accordance with the USEPA's SW-846, Method 6200. Five readings will be taken from each sample and recorded in the fieldbook and the results averaged to provide the uncorrected representative concentration. A minimum of 20 percent of the soil samples will be submitted to the Quality Assurance Analytical Laboratory for total lead analysis. The laboratory results will be evaluated against the corresponding average XRF concentration and a correction factor (regression equation) will be developed for each parameter as discussed in Section 2.1. The correction factor will be applied to those XRF sample results without a corresponding laboratory result. The corrected average will be compared against the soil standards listed in the CM Design Report. If the corrected average is less than the soil standards, then the excavation area will be deemed complete. If the corrected average is greater than the soil standards, then additional excavation will be performed within portions of the excavation area as designated by the QA Representative. The amount of additional removal will be determined by the QA Representative based on the observed sampling results and visual conditions within the excavation. After re-excavation the remediated portions will be resampled at locations approximating the locations of the previous samples and analyzed with the XRF following the same protocol described above. The average XRF result will be corrected using the correction factor. This process shall be repeated until acceptable results are achieved.

If distinct layers or pockets of slag or battery casing materials are observed in the bottom or sidewalls of the excavation area, the QA Representative will require selective removal of the identified material.

APPENDIX B

EARTHWORK

Final CM Design
CQAP Appendix B
Refined Metals Corporation
Beech Grove, Indiana
March 21, 2011

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1.0 INTRODUCTION

1.1 TERMS OF REFERENCE

1.1.1 Purpose

This appended section of the Construction Quality Assurance Plan (CQAP) addresses quality assurance requirements for earthwork operations during implementation of the Corrective Measures at the RMC facility Beech Grove, Indiana. The appendix details construction monitoring activities, soil sampling, soil testing and documentation.

1.1.2 References

ASTM D 421 Test Method for Dry Preparation for Soil Samples for Particle-Size Analysis and Determination of Soil Constants.

ASTM D 422 Test Method for Particle-Size Analysis of Soils

ASTM D 698 Test Method for Moisture-Density Relations of Soils and Soil Aggregate Mixtures Using a 5.5-lb (249-kg) Rammer and 12-inch (305-mm) Drop.

ASTM D 1556 Test Method for Density of Soil In Place by the Sand-Cone Method

ASTM D 1557 Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10-lb (4.54-kg) Rammer and 18-in. (457-mm) Drop

ASTM D 2487 Test Method for Classification of Soils for Engineering Purposes

ASTM D 2922 Test Methods for Density of Soil and Soil-Aggregate In Place by Nuclear Methods (Shallow Depth)

ASTM D 3017 Test Method for Water Content of Soil and Rock In Place by Nuclear Methods (Shallow Depth)

ASTM D 4318 Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils

1.2 MEETINGS

To maintain a high degree of quality during earthwork operations, open channels of communication are required. Project Progress Meetings will be conducted as required by Specification Section 01200.

2.0 SOIL EVALUATION

The Contractor will provide as a pre-construction submittal laboratory analytical and geotechnical results for each of the proposed off-site soil and topsoil borrow sources proposed for use on this project. The soil evaluation shall be repeated each time a material variation is noted by the QA Representative in the field and for each new borrow source. The Contractor shall submit the samples to an independent laboratory for the following test:

GEOTECHNICAL PROPERTIES

Property	Test Method
Gradation	ASTM D 422
Plasticity	ASTM D 4318
Unified Soil Classification	ASTM D 2487
Modified Proctor Compaction	ASTM D 1557
Atterberg Limits	ASTM D 423 and D 424

Note: Modified Proctor Compaction Analysis is not required for propose topsoil sources.

ANALYTICAL TESTING

Analyte	Method
TAL Metals	SW-846 6010/6020
TCL VOCs	SW-846 8260B
TCL SVOCs	SW-846 8270C

Soil fill sources may not be from off-site industrial property borrow source. Quarry sources for aggregate and sand materials must be identified before the project begins and state-permitted borrow quarries are required.

Material which does not meet the project specifications and satisfaction of RMC shall not be used at the site. The QA representative, in consultation with the CM Engineer shall determine the acceptability of soil fill material with respect to the project specifications (Section 02210).

3.0 PLACEMENT AND COMPACTION

3.1 WEATHER CONDITIONS

Placement of soil fill shall be suspended if climatic conditions are inappropriate, as determined by the QA Representative. Precipitation and cold weather may prohibit fill placement. Soil fill shall not be placed when the material to be placed or the surface of the material in-place is frozen or wet.

3.2 FOUNDATION PREPARATION

Areas which are to receive soil fill shall be proofrolled prior to soil placement. Areas with free or standing water are to be considered unacceptable. Areas which exhibit excessive pumping or yielding shall be reworked and recompacted or undercut and replaced. The Contractor is responsible for the subrgade condition. The QA Representative shall determine and document the acceptability of soil fill areas.

3.3 FILL PLACEMENT

All cap soil fill shall be placed to the lines and grades shown on the project drawings. Survey controls required for earthwork placement shall be established by a professional surveyor. Controls shall be established based upon the vertical and horizontal reference system develop by the Contractor's Surveyor prior to soil remediation activities.

The QA Representative shall observe soil placement. Vegetation, organic matter, trash, debris, oversized stones or other unsuitable materials shall be removed from the fill soil. Imported soil fill with excessive quantities of deleterious material, as determined by the QA Representative, shall be removed from the site. Soil fill shall be placed in lifts with a loose lift thickness of 12 inches or less.

Successive layers of fill may not be placed until the preceding fill layer has been properly compacted, as determined by the QA Representative.

The QA Representative shall visually monitor the soil as delivered to the site. The QA Representative shall assure that the soil color, texture, consistency, gradation and plasticity are in accordance with the material accepted during the pre-construction evaluation. The QA Representative may require that the Contractor collect and re-analyze material samples to assure that the fill soil conforms with the project specifications and that the fill soil is the same material accepted by the pre-construction evaluation.

Fill soil samples shall be obtained by the Contractor at the frequency indicated below or whenever a variation in the fill material is observed. Samples shall be submitted to an independent laboratory to determine the following properties:

Property	Test Method	Frequency
Gradation	ASTM D 422	3,000 CY
Atterberg Limits	ASTM D 423 and 424	3,000 CY
Plasticity	ASTM D 4318	3,000 CY
Unified Soil Classification	ASTM D 2487	3,000 CY
Modified Proctor Compaction	ASTM D 1557	3,000 CY
Analytical Testing	(see Section 2.0)	Prior to approval and as needed (off-site)

Samples which have gradation, plasticity and material classification properties which vary significantly from those determined during the soil evaluation shall be re-tested. The QA Representative shall determine the necessity for shear strength testing. Imported material which does not meet the project specifications shall be removed from the site. The QA Representative shall determine the acceptability of soil fill material with respect to the project specifications. Any discrepancies or questions shall be clarified with the CM Engineer.

The Earthwork Contractor is responsible for maintaining and protecting fill areas from damage until final completion of the project. Travel over fill areas shall be restricted to prevent rutting or other degradation. Completed fill areas that are damaged following placement shall be scarified, filled and re-compacted to the satisfaction of the QA Representative.

3.4 COMPACTION

Compaction shall be observed by the QA Representative. The QA Representative shall observe the compaction equipment, number of passes and completeness of coverage. Soil fill shall be compacted to at least 92% of the maximum dry density as determined by the modified Proctor test, ASTM D 1557. In addition to the compaction requirement, Cap Soil Fill shall have a moisture content ranging from -5% to +3% of the optimum.

The compaction characteristics for fill soils shall be determined by an independent laboratory retained by the Contractor. A sample shall be collected by the Contractor once for every 3,000 CY or when a significant material variation is noted. The compaction characteristics shall be determined, including maximum dry density and optimum moisture content, according to ASTM D 1557. The resultant information will establish field compaction criteria.

The QA Representative shall determine the acceptability of soil compaction. Evaluation shall be based upon visual observation of material stability and in-place density testing. In-place density testing shall be performed by the Contractor's Quality Control representative by nuclear density methods, ASTM D 2922 and D 3017, at a frequency of once for every 1,000 SF placed and once per lift. If nuclear density methods are determined to be inappropriate, in-place density shall be determined according to ASTM D 1556. In-place density results must be included with daily project reports. Any soil reworking and re-compaction, as determined by the QA Representative, shall be performed by the Contractor.

3.5 ANCHOR TRENCH

The Contractor shall excavate and backfill the anchor trench for the cap systems geosynthetics and anchor trench drain according to the project specifications and quality assurance procedures outlined in the accompanying Construction Quality Assurance Plan for Geosynthetic Lining System Installation. The QA Representative shall observe anchor trench construction and backfilling.

4.0 EARTHWORK ACCEPTANCE

4.1 CONTRACTOR

The Contractor retains all ownership for the soil fill until accepted by the RMC. The Contractor remains responsible for the condition of the soil subbase until the geosynthetic lining system is installed.

4.2 RMC

RMC will accept soil fill when:

1. Soil evaluation testing is complete and the soil fill has been shown to meet project specifications.

2. Placement and compaction is completed.

3. In-place density results, daily field reports and compaction test data have been submitted.

4. As-built drawings, sealed by a registered Professional Surveyor, have been received by the Owner. As-built drawings should show elevations of the starting ground surface, bottom of excavations, restored ground surface, bottom of containment cell, top of waste in containment cell and top of cap.

APPENDIX C

GEOSYNTHETICS INSTALLATION

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LIST OF FORMS

1.0 INTRODUCTION

1.1 TERMS OF REFERENCE

1.1.1 Purpose

This manual addresses the Quality Assurance and Quality Control of the installation of high density polyethylene (HDPE) geomembrane and composite drainage net for Refined Metals Corporation Beech Grove (RMC). The manual delineates the quality procedures and standards required for production and installation.

For purposes of this document, the term "geomembrane" refers to the 60 mil textured HDPE geomembrane layer of the proposed containment cell cap as described in Section 02755 of the Specifications. The term "composite drainage layer" net shall mean the double side drainage layer as described in Section 02751 of the Specifications.

1.1.2 Quality Assurance

Quality Assurance is defined as a planned and systematic pattern of all means and actions designed to provide adequate confidence that items or services meet contractual and regulatory requirements and will perform satisfactorily in service. This section also provides a methodology for resolving problems which may occur during construction.

1.1.3 Quality Control

Quality Control is defined as those actions which provide a means to measure and regulate the characteristics of an item or service in accordance with contractual and regulatory requirements.

1.1.4 References

ASTM D 570	Test Method for Water Absorption of Plastics
ASTM D 638	Test Method for Tensile Properties of Plastics
ASTM D 746	Test Method for Brittleness Temperature of Plastics and Elastomers by Impact
ASTM D 792	Test Method for Specific Gravity (Relative Density) and Density of Plastics by Displacement
ASTM D 882	Test Method for Properties of Plastic Sheeting
ASTM D 1004	Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM D 1204	Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
ASTM D 1238	Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer
ASTM D 1505	Test Method for Density of Plastics by the Density-Gradient Technique
ASTM D 1603	Test Method for Carbon Black in Olefin Plastics
ASTM D 1682	Test Method for Strip Tensile Strength
ASTM D 1693	Test Method for Environmental Stress Cracking of Ethylene Plastics
ASTM D 2663	Test Method for Rubber Compounds-Dispersion of Carbon Black
ASTM D 3015	Test Method for Microscopical Examination of Pigment Dispersion in Plastic Compounds
ASTM D 4354	Standard Practice for Sampling of Geosynthetics for Testing
ASTM D 4437	Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes
ASTM D 4533	Test Method for Trapezoid Tearing Strength of Geotextiles
ASTM D 4595	Test Method for Tensile Properties of Geotextiles by Wide Width Strip
ASTM D 4632	Test Method for Breaking Load and Elongation of Geotextile (Grab Method)

ASTM D 4716	Test Method for Constant Head Hydraulic Transmissivity of Geotextiles and Geotextile Related Products
ASTM D 4759	Standard Practice for Determining the Specification Conformance of Geosynthetics
ASTM D 4833	Test Method for Index Puncture of Geotextiles, Geomembranes and Related Products
ASTM D 5084	Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
ASTM D 5321	Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosnythetic Friction by the Direct Sheer Method.

GRI Test Method GM6 - Pressurized Air Channel Test for Dual Seamed Geomembranes

NSF Standard 54 (1991 or current) Flexible Membrane Liners

2.0 GEOSYNTHETIC MANUFACTURING AND TRANSPORTATION

2.1 GEOSYNTHETIC PROPERTIES CERTIFICATION

2.1.1 Geomembrane Raw Material

The geomembrane manufacturer is responsible for the production of geomembrane rolls from resin.

Upon delivery, the following shall be furnished by the Manufacturer:

1. Reports on tests performed by the Manufacturer to verify the quality of the resin used in the geomembrane rolls proposed for use on the project. The tests should include the following:

Required Material Properties for HDPE

TEST	METHOD	NOTES	REQUIREMENTS
SPECIFIC GRAVITY (1)	ASTM D 792 OR D 1505	1 and 2	≥0.940
CARBON BLACK CONTENT	ASTM D 1603	2	2 to 3%
MELT INDEX	ASTM D 1238 (Condition E MAX)	1 and 2	0.3 g per 10 minutes

(1) Measure prior to adding carbon black.
(2) 1 per 50,000 square feet of 1 per resin batch whichever results in a more number of tests.

2.1.2 Geomembrane

The Installer shall submit certification that all geomembrane rolls brought to the site meet the following requirements or the Manufacturers minimum published values, whichever is more restrictive. Adherence to this requirement shall be made a condition of the material purchase order.

Required Material Properties for 60 mil Textured HDPE Geomembrane

PROPERTY	TEST METHOD	TYPICAL VALUE
Thickness, mils, Minimum 1. Overall	ASTM D1593	57
Density (g/cc), minimum	ASTM D 792 or D1505	0.94
Tensile Properties	ASTM D638-NSF Modified	
1. Strength at Yield (lb/in width), minimum		126
2. Strength at Break (lb/in width), minimum		90
3. Elongation at Yield (percent), minimum		12
4. Elongation at Break (percent), minimum		100
Tear Resistance (lb) minimum	ASTM D1004	39
Low Temperature Brittleness (°C), maximum	ASTM D 746	-60
Dimensional Stability, Percent Change, Maximum	ASTM D 1204 100°C, 1 hr	+/-2.0
Environmental Stress Crack (hrs) minimum	ASTM D1693-NSF Modified	1500
Puncture Resistance, lbs., Minimum	ASTM D4833	72
Carbon Black Content (%), range	ASTM D 1603	2.0 - 3.0
Carbon Black Dispersion	ASTM D3015-NSF Modified	A1, A2

For each geosynthetic material used at the site, the Installer shall provide the following to the QA Representative:

1. A properties sheet including specified properties and testing methods.
2. A certification that property values given in the properties sheet are guaranteed by the Manufacturer.
3. Geosynthetic delivery, storage, and handling instructions.
4. One quality control certificate for every roll of geomembrane. This certificate shall include roll numbers and identification. The finished rolls shall be identified by a number corresponding to the particular batch of resin used.

The following information shall also be provided by the Installer for any extrudate used for the project.

1. Certification stating that all extrudate is from the same Manufacturer and is of the same resin type as the geomembrane seamed.
2. Copy of quality control certificates issued by the Manufacturer

2.1.3 Geotextile

The Installer shall submit certification that geotextile rolls for use in the geocomposite and anchor trench and beneath the cap geomembrane meet the following requirements or the Manufacturers minimum published values, whichever is more restrictive. Adherence to this requirement shall be made a condition of the material purchase order:

Required Material Properties of Geotextile

Properties	Test Method	Required Value – Geocomposite	Required Value – Geotextile under geomembrane
Grab Strength (lbs.), min.	ASTM D 4632	150	200
Puncture Resistance (lbs.), min.	ASTM D 4833	75	100
Tear Strength (lbs.), min.	ASTM D 4533	70	80
Mass per Unit Area (oz/sy), min.	ASTM D 3776	8	8
Apparent Opening Size (US Sieve No.)	ASTM D 4751	80	

The Installer shall provide the QA Representative with a copy of geotextile manufacturer's recommended installation procedures to be followed during geotextile installation.

2.1.4 Geonet (Geocomposite)

The Installer shall submit certification that all geonet rolls brought to the site meet the following requirements or the minimum published values, whichever is more restrictive. Adherence to this requirement shall be made a condition of the material purchase order:

Required Material Properties of HDPE Geonet

Properties	Test Method	Required Value
Transmissivity (M^2/S), min.	ASTM D 4716 i = 1.0 σ = 2,000 psf	1.4×10^{-3}
Tensile Strength (lb/in), min.	ASTM D 1682 or D 4595	22

2.1.5 Interface Friction

The Contractor shall test geosynthetic and soil layers by shear box testing (ASTM D 5321) to demonstrate the following minimum values are met:

Representative sample of site soil to Geotextile	22°
Geotextile to Textured Geomembrane	22°
Nonwoven Geotextile (Geocomposite) to Textured Geomembrane	22°
Nonwoven Geotextile (Geocomposite) to Proposed Cap Soil	22°

2.2 TRANSPORTATION AND HAULING

Geosynthetic rolls or panels shall be packaged and shipped by appropriate means so that no damage is caused. Transportation shall be the responsibility of the Installer.

2.2.1 Delivery

Off-loading and storage of the geosynthetics is the responsibility of the Installer. The Installer shall be responsible for replacing any damaged or unacceptable material at no cost to RMC. No off-loading shall be done unless the QA Representative is present. Any damage occurring during the off-loading shall be documented by the Installer and QA Representative. All damaged rolls shall be separated from undamaged rolls and stored at locations designated by the QA Representative until Installer can remove damaged materials from the site. The QA Representative will be the final authority on determination of damage. All unacceptable materials shall be removed from the site by the Installer.

The QA Representative shall visually inspect the surface of all rolls for defects and/or damage, unrolling only if necessary. Any flaws shall be immediately reported and documented.

The Installer shall take care that any equipment used in handling the geomembrane does not cause damage during the off-loading process. Appropriate handling equipment includes cloth chokers and spreader bars for loading, spreader and roll bars for deployment. Dragging panels on ground surfaces shall not be permitted. The Installer shall also assure that all personnel handle the geomembrane with care, so as not to damage the material. Geomembrane material shall not be folded; folded material shall be rejected.

Form 1 shows an example of a Material Delivery Report to be completed by the QA Representative.

2.2.2 On-Site Storage

Storage of geosynthetics shall protect them from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, or any other damage.

Storage space shall be near the site to be lined, to minimize additional handling. It shall be protected against theft, vandalism, passing vehicles, and any other hazards.

Geosynthetic rolls shall be stored on prepared surface, i.e., a smooth surface without obstructions and/or debris, (not on wooden pallets). Geosynthetic rolls may be stacked per Manufacturers recommendations but no more than three rolls high.

2.3 MATERIAL CONFORMANCE

Independent material conformance testing is not required. The Installer shall submit certifications from the geosynthetic manufacturers that the material delivered to the site meet the requirements established in this CQAP and the Specifications. Geosynthetic materials may not be used until conformance certifications are received and approved by the QA Representative. The QA Representative shall determine the acceptability of geosynthetic components. Determinations regarding the acceptability of materials not meeting the specifications can only be made by the Engineer.

3.0 GEOMEMBRANE INSTALLATION

3.1 EARTHWORK

Immediately prior to installation of the designed geosynthetic components of the cap system, the subbase surface shall be observed by the QA Representative and Installer. The decision to repair ruts or depressions, if any, shall be made by the QA Representative and Installer. The Contractor shall repair any unacceptable subbase.

All recommendations and work performed on the subbase prior to installation shall be recorded.

No liner shall be placed on surfaces not previously found acceptable to the QA Representative and Installer. If requested, the Installer must also provide USEPA and/or IDEM an opportunity to inspect the subbase prior to geosynthetic placement.

The Contractor shall be responsible for preparing and maintaining the subbase in a condition suitable for installation of the liner unless specifically agreed otherwise. Contractor responsibilities include:

1. Surfaces to be lined shall be smooth, and free of debris, roots, and angular or sharp stones larger than 2-inches. The subbase shall be compacted in accordance with the design specifications but in no event below the minimum required to provide a firm unyielding foundation sufficient to permit the movement of vehicles and welding equipment over the subbase without causing rutting. The subbase shall have no sudden or abrupt changes in grade.

2. Protection of the subbase from erosion and water ponding. Protection, if required, may consist of a thin plastic protective cover (or other material as approved by the QA Representative) installed over the completed subbase until such time as the placement of liner begins. The plastic sheeting must be removed prior to geosythetic deployment as the presence of the plastic may cause interface sliding or failure.

3. Cap anchor trench excavation and preparation.

4. All earthwork operations as detailed in the design specifications. Earthwork quality assurance shall also be performed in accordance with the Construction Quality Assurance Plan for Earthwork.

3.2 ANCHOR TRENCH

3.2.1 Excavation

The cap anchor trench shall be excavated to the line, grade, and width shown on the construction drawings, prior to cap system geosynthetic placement. The QA Representative shall verify that the anchor trench has been constructed according to the project drawings. The anchor trench shall be excavated by the Contractor. If anchor trench is excavated in a clayey soil susceptible to desiccation, no more than the amount of trench required for the lining system to be anchored in one day shall be excavated to minimize desiccation potential of the anchor trench clay soils. Rounded corners shall be provided in and at the top of the trench so as to avoid sharp bends in the geomembrane.

3.2.2 Backfilling

The anchor trench shall be adequately drained to prevent ponding or otherwise softening of the adjacent soils while the trench is open. The anchor trench shall be backfilled by the Earthwork Contractor as outlined in the project specifications. Care should be taken when backfilling the trenches to prevent any damage to the cap geosynthetics or drainage pipe. If damage occurs, it shall be repaired by the Installer prior to the completion of the backfill.

3.3 WEATHER CONDITIONS

Welding shall not take place during any precipitation, in the presence of excessive moisture i.e., fog, dew, frost, in areas of ponded water or in presence of excessive winds, (unless wind barriers are provided).

Seaming may proceed if the geomembrane sheet temperature is above 32°F (0°C), or if it can be proven via test strips that good seams can be fabricated at lower temperatures. The QA Representative shall determine the acceptability of cold weather seaming.

Seaming may proceed if the sheet temperature is below 122°F (50°C), or if it can be proven via test strips that quality seams can be fabricated at higher temperatures. The QA Representative shall determine the acceptability of hot weather seaming. Sheet temperature should be measured by an infrared thermometer or surface contact thermocouple.

3.4 METHOD OF PLACEMENT

3.4.1 Installer Responsibility

The Installer shall be responsible for the following:

1. No equipment or tools shall damage the geosynthetic by handling, trafficking, or other means.

2. No personnel working on the lining system shall smoke, wear damaging shoes, or engage in other activities that could damage the geosynthetics.

3. The method used to unroll the panels shall not cause scratches or crimps in the geomembrane and shall not damage the supporting soil.

4. The method used to place geomembrane panels shall minimize wrinkles. Wrinkles shall be identified as to proper location by the Installer and shall be shown on the Installer's as-built drawings. Ballast shall be used to prevent relocation of the compensating wrinkles by wind.

5. Bridging shall be removed, unless accepted by the QA Representative.

6. Adequate loading (i.e., sandbags) shall be placed to prevent uplift by wind. (In case of high winds, continuous loading is recommended along the edges of panels to minimize risk of wind flow under the panels).

7. Direct contact with the geomembrane shall be minimized, i.e., the geomembrane in traffic areas is to be protected by geotextiles, extra geomembrane, or other materials approved by the QA Representative.

8. Panels shall not be skewed from the vertical unless presented in the panel layout plan and approved by the CM Engineer.

3.4.2 Field Panel Identification

A field panel is the unit area of geomembrane which is to be seamed in the field, i.e., a field panel is a roll or a portion of a roll cut in the field. Each field panel shall be given an "identification code" consistent with the layout plan. This code shall be as simple and logical as possible.

3.4.3 Field Panel Placement

Field panels are installed at the locations indicated by the layout plan. Field panels may be installed in either way:

1. All field panels are placed prior to field seaming. No more panels may be placed than can be seamed by the end of the day.

2. Field panel are placed one at a time, and each panel is seamed immediately after its placement (in order to minimize the number of unseamed field panels).

Each panel placement should be recorded immediately using the daily deployment report. Identification code, location and date shall be recorded. Form 2 is used as a record of daily deployment. Form 2 shall be completed by the QA Representative. All panels that are folded shall be replaced by the Installer.

3.5 FIELD SEAMING

3.5.1 Procedures

The welding or seaming procedure consists of overlapping the two geomembrane sheets such that any liquid flowing across the seams would flow from the top panel to underlying panel.

Seams shall be oriented parallel to the slope, i.e., oriented along, not across the slope. In corners and odd shaped geometric locations, the number of field seams should be minimized.

Seams shall be aligned with the least possible number of wrinkles and "fishmouths." If a "fishmouth" or wrinkle is found, it shall be cut, removed and patched.

Personnel performing field seaming shall meet the following requirements:

1. Master Seamer Qualifications: The Master Seamer shall have completed a minimum of 500,000 square feet of geomembrane seaming work using the type of seaming apparatus proposed for use on this project.

2. Other Seamer Qualifications: Other seamers shall have seamed a minimum of 100,000 square feet of geomembrane.

3. The Master Seamer shall provide direct supervision over other seamers.

Details of each seam, including seamer, machine number, time, and temperature shall be recorded by the QA Representative on the Pre-Weld and Geomembrane Seaming Record (Form 4).

3.5.2 Pre-Weld/Trial Weld

Pre-welds or trial welds shall be taken to verify the performance of welding equipment, seaming methods, and conditions. No seaming equipment or seamer shall be allowed to perform production welds until equipment and seamers have successfully completed trial weld(s). Pre-welds should be made in the same surroundings and environmental conditions as the production welds, i.e., in contact with the subgrade. Pre-welds shall be performed at the following frequency:

1. At all start-ups and prior to planned shut-downs.
2. Throughout the day as equipment requires start-up after a breakdown.

Samples should be at least 3 feet long and 1 foot wide with the seam centered lengthwise. (Typically the samples are made by the welder seaming two piece of the geomembrane together). Ten one-inch wide strips should be cut from the trial weld.

Specimens should be quantitatively tested by the Installer for peel adhesion for bonded seam strength (shear) using a recently calibrated field tensiometer. A specimen is considered to pass when the test results are consistent with test requirements established in Section 3.7.

A trial weld sample shall be considered passing if at least eight specimens pass peel and shear tests. Five shall be tested in peel mode and five in sheer mode.

Repeat the trial weld in its entirety when any of the trial weld samples fail in either peel or shear. When repeating trial welds fail, seaming apparatus and seamer shall not be used for production welding until deficiencies or conditions are corrected and two consecutive successful trial welds are achieved.

All trial welds shall be recorded by the QA Representative on Form 3 (Pre-Weld and Geomembrane Seaming Record).

3.5.3 Equipment

Hot dual wedge welders and hand held extrusion welders are the pieces of equipment approved for field seaming. The Installer is expected to utilize the dual wedge welder to the maximum extent possible and utilize the hand held extrusion welder for patches and finishing work.

Hot Wedge Welding

Consists of placing a heated wedge, mounted on a self propelled vehicular unit, between 2 overlapping sheets which are heated above the polyethylene's melting point. After being heated by the wedge, the overlapping panels pass through a set of preset pressure wheels which compress the panels together to create a fusion weld. A dual track wedge welder will create two fusion welds separated by an unwelded channel.

The double wedge fusion welder shall be equipped with a temperature readout device which continuously monitors the temperature of the wedge.

Other equipment used during seam operations includes field tensiometer, rotary grinders, electric generators, coupon die and press and manometers/air pumps.

A recently calibrated field tensiometer shall be used for sheer and peel testing. The device shall have a load range of 0 to 500 pounds, a peak hold function and digital readout. Speed settings or 2" or 20" per minute shall be available.

Properly functioning portable electric generators must be available within close proximity of the seaming region and with adequate extension cords to complete the entire seam. These generators should be of sufficient size or numbers to handle all seaming electrical requirements. The generator must have rubber tires, be placed on a smooth plate such that it is completely stable that no damage can occur to the geomembrane or to the underlying liner or subgrade material. Fuel (gasoline or diesel) for the generator must be stored away from the geomembrane and if accidently spilled on the geomembrane must be immediately removed. The area should be inspected for damage to the geomembrane and repaired if necessary.

If applicable, manometers for testing air channel welds provided with a heavy duty needle or other approved pressure feed device, an air pump shall be provided. Two manometers shall be used in the Air-Pressure test.

A coupon die and press shall be supplied for cutting peel and shear specimens for trial seaming.

3.5.4 Seam Preparation

For wedge welding, seam preparation shall include:

1. The panels of the geomembrane shall be overlapped at least four-inches.

2. The seam area shall be cleaned prior to seaming to assure the area is clean and free of moisture, dust, dirt and debris of any kind. No grinding is required for fusion welding.

3. The panels shall be adjusted so that seams are aligned with the fewest possible number of wrinkles and "fishmouths."

4. A moveable protective layer may be used directly below the overlap of geomembrane that is to be seamed to prevent build-up of moisture between the panels.

3.6 NON-DESTRUCTIVE SEAM TESTING

Purpose of non-destructive testing is to check the continuity of the seam. The Installer shall non-destructively test all field seams over their full length. All test equipment shall be furnished by the Installer.

3.6.1 Vacuum Box Testing

Equipment for vacuum box testing shall consist of the following:

1. A vacuum box assembly consisting of a rigid housing, a transport viewing window, a soft neoprene or rubber gasket attached to the bottom, a valve assembly, and a vacuum gauge.

2. A steel vacuum tank and pump assembly equipped with a pressure controller and pipe connections.

3. A rubber pressure/vacuum hose with fittings and connections.

4. A plastic bucket and wide brush (or spray assembly).

5. A soapy solution.

The following procedure shall be used by the Installer:

1. Excess sheet overlap (if any) shall be trimmed away.

2. The window and gasket surfaces shall be cleaned and checked for leaks.

3. The vacuum pump shall be energized and the tank pressure shall be reduced to approximately 5 psi.

4. A strip of the geomembrane shall be wetted approximately 12 inches by 48 inches (length of the box) with a soapy solution. Size of the wet area depends on the size of the vacuum box.

3. The box shall be placed over the wetted area and compressed. Steel reinforcement that comes in contact with the liner shall not have any burs, sharp points, etc.

4. The bleed valve shall be closed and the vacuum valve shall be opened.

5. It shall be verified that a tight seal is created.

6. For a period of approximately 15 to 30 seconds, the geomembrane shall be examined through the viewing window for the presence of soap bubbles.

7. If no bubbles appear, the vacuum valve shall be closed, the bleed valve shall be opened, and the box shall be moved to the adjoining area with a minimum of 3 inches overlap. The process shall then be repeated.

8. All areas where soap bubbles appear shall be marked and repaired and then retested.

9. Vacuum box results should be recorded by the QA Representative on the Non-Destructive Seam Testing Form (Form 4). All vacuum box test shall be observed by the QA Representative.

3.6.2 Air-Pressure Testing

Air pressure testing is applicable to those processes which produce a double seam with an enclosed space. This method should be used by the Installer rather than vacuum box testing, to the maximum extent possible.

Equipment for testing air-pressure testing shall include:

1. An air pump equipped with a pressure gauge capable of generating and sustaining a pressure between 25 to 30 psi and mounted on a cushion to protect the geomembrane. The air pump may be manual or motor driven.

2. A manometer equipped with a sharp hollow needle, or other approved pressure feed device.

The following procedures shall be followed by the Installer:

1. Both ends of the seam area to be tested shall be sealed.

2. A manometer or other approved pressure gauge shall be inserted into both ends of the channel created by the double wedge or extrusion double wedge fusion welds. Means of pressurizing must be provided.

3. The air pump shall be energized to verify the unobstructed passage of air through the channel. The QA Representative shall verify unobstructed air flow.

4. The air pump shall be energized to pressure between 25 and 30 psi, the valve shall be closed, and the pressure shall be sustained for 5 minutes.

5. If there is a loss of pressure exceeding 4 psi, or the pressure does not stabilize, the faulty area shall be located, repaired, and retested.

6. The needle or other approved pressure feed device shall be removed and the hole sealed. The air channel at the other end shall be opened to insure that air pressurized the entire channel prior to removing the feed device.

7. Test results shall be recorded by the QA Repersentative on the Non-Destructive Air Pressure Seam Testing Summary (Form 4).

3.7 DESTRUCTIVE SEAM TESTING

Purpose of destructive testing is to determine and evaluate seem integrity and assess long-term performance.

3.7.1 Location and Frequency

The Installer shall provide the QA Representative with minimum of one destructive test sample per 500 feet of seam length from a location specified by the QA Representative; individual samples may be taken at greater or lesser intervals.

Additional destructive tests may be taken in areas of contamination, offset welds, visible crystallinity or other potential cause of faulty welds, as determined by the QA Representative.

The seaming technician (or Installer) shall not be informed in advance of the locations where the seam samples will be taken.

3.7.2 Sampling Procedure

In order to obtain test results prior to completion of liner installation, samples shall be cut by the Installer as seam progresses at the locations designated by the QA Representative.

The Installer shall mark all samples with the date and seam sample number. The Installer should also record, the date, location, time, and seam number for each specimen taken.

All holes in the geomembrane resulting from obtaining the seam samples shall be immediately repaired. All patches shall be vacuum tested. Sample locations should be located on the as-built drawing. All destructive seam samples shall be recorded by the QA Representative on the Destructive Sample Record (Form 5). Information to be recorded includes date, sample number, seam number, machine number, seamer, date sent to lab and a summary of any field test performed.

3.7.3 Size of Samples

The samples shall be 18 inches wide by 36 inches long with the seam centered lengthwise. This sample is usually cut in thirds, two pieces given to the QA Representative and the other given to the liner Installer. The QA Representative shall send one sample to an independent laboratory for testing. The other sample will be archived by the QA Representative in the event future testing is required.

3.7.4 Seam Testing Requirements

Destructive testing involves two techniques: Shear strength and peel adhesion. Destructive testing will be conducted by the Installer and QA Representative.

Shear testing will be performed in accordance with ASTM D 4437-NSF modified. This test involves placing a tensile stress from the top sheet through the weld and into the bottom sheet. Peel testing shall be performed in accordance with ASTM D 4437-NSF modified. This test involves peeling the sheets apart to observe how separation occurs. Results indicate whether or not the sheets are continuously and homogeneously connected through the seam.

Ten 1-inch wide replicate specimens shall be cut from the sample. Five specimens shall be tested for shear strength and five for peel adhesion. The test seam area will be considered acceptable if four of the five samples for each test fail outside of the seam area, provided all five samples must meet the following strength requirements:

SEAM PROPERTIES FOR 60 MIL TEXTURED HDPE GEOMEMBRANE

TEST	TEST METHOD	FAILURE CRITERIA
Shear Strength	ASTM D4437-NSF Modified	100 lb/in (minimum), FTB, greater than 100% elongation
Peel Adhesion	ASTM D4437-NSF Modified	75 lb/in minimum, FTB, less than 10% separation

3.7.5 Independent Laboratory Testing

The QA Representative shall package and ship to the independent laboratory, one section of every seam sample taken for third party determination of seam integrity. The samples shall be tested in accordance with the seam testing requirements. Discrepancies between project seam requirements and Manufacturer's requirements will be handled by adopting the most stringent requirement.

3.7.6 Procedures for Destructive Test Failure

One of the following procedures shall apply whenever a sample fails a field destructive test:

1. The Installer shall cap strip the seam between the failed location and any passed test location.

2. At the QA Representative discretion, the Installer can retrace the welding path to an intermediate location (at a minimum of 10 feet from the location of the failed

test), and take a sample for an additional destructive seam test. If this test passes, then the seam shall be cap stripped between that location and the original failed location. If the test fails, the process is repeated.

3. Over the length of seam failure, the contractor shall either cut out the old seam, reposition the panel and reseam, if possible, or add cap strip, as required by the QA Representative.

The QA Representative shall document all actions taken in conjunction with destructive test failures.

3.8 DEFECTS AND REPAIRS

3.8.1 Identification

All seams and the entire geomembrane surface shall be observed by the QA Representative for defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter. Unacceptable panels shall be removed and replaced. Because light reflected by the geomembrane helps detect defects, the surface of the geomembrane shall be clean at the time of observation. Reflecting light will cause the surface of the geomembrane, at locations where there are imperfections, to appear white or light in color. The geomembrane surface shall be brushed, blown, or washed by the Installer if the amount of dust or mud inhibits observation, as determined by the QA Representative.

3.8.2 Evaluation

Any suspect locations shall be non-destructively tested as appropriate in the presence of the QA Representative. Each location that fails the non-destructive testing shall be marked by the QA Representative, and repaired accordingly.

3.8.3 Repair Procedures

Any portion of the geomembrane exhibiting a flaw or failing a destructive or non-destructive test shall be repaired.

1. Defective seams shall be restarted/reseamed as described in these specifications.

2. Long lengths of failed seams shall be capstripped.

3. Tears shall be repaired by patching. Where the tear is on a slope or an area of stress and has a sharp end it must be rounded by cutting prior to patching.

4. Blisters, holes, undispersed raw materials, and contamination by foreign mattery shall be repaired by large patches.

5. Surfaces of the geomembranes which are to be patched shall be cleansed and lystered.

6. Folds shall be removed or patched.

Patches shall be round or oval in shape, made of the same geomembrane, and extended a minimum of 6 inches beyond the edge of defects. All patches shall be the same compound and thickness as the geomembrane specified. All patches shall have their top edge beveled with a grinder prior to placement on the geommembrane. Patches shall be applied using approved methods only.

All surfaces must be clean and dry at the time of repairs. All seaming equipment used in repairs must be approved by the QA Representative and Installer. All repair procedures, materials, and techniques shall be approved in advance of the specific repairs by the QA Representative and Installer.

Form 6 (FML Repair Locations) shall be used by the QA Representative for documenting repairs.

3.8.4 Verification of Repairs

Each repair shall be non-destructively tested. Repairs that pass the non-destructive test shall be taken as an indication of an adequate repair. Failed tests indicate that the repair shall be repeated and retested until passing test results are achieved. The QA Representative shall take additional destructive seam samples, as necessary, for long lengths of cap stripped seam.

Recording of results: daily documentation of all non-destructive and destructive tests shall be prepared by the QA Representative. This documentation shall identify all seams that initially fail destructive testing and indicate evidence that these seams were repaired and successfully retested. Documentation shall identify all patch, bead or cap strip locations and indicate that repairs were made and successfully tested.

Repair documentation shall include:

1. Panel and seam location.

2. The type of repair, i.e., patch, bead, cap strip, etc.

3. Identification of any cap strips that are repairs for failing a destructive seam test.

4. Vacuum test results on repairs.

5. Precise location of the repair.

4.0 GEOCOMPOSITE AND GEOTEXTILE INSTALLATION

4.1 HANDLING AND PLACEMENT

The geocomposite (geotextile/geonet/geotextile), geonet and geotextile shall be handled in a manner to ensure it is not damaged. Prior to and during placement, the Installer and QA Representative shall assure that:

1. The portion of the geomembrane to be covered by the composite drainage layer, geonet or geotextile has all required documentation complete.

2. The surface of the geomembrane must not contain stones or excessive dust that could cause damage. Prior to placing the composite drainage layer, the liner shall be swept clean with a soft bristle broom.

3. In the presence of winds, all geosynthetics shall be weighted with sandbags, as necessary. The Installer shall be responsible for damage caused by wind.

4. Geosynthetics shall be cut using an approved cutter, similar to a hooked razor blade. No straight blades are permitted. Care must be taken to protect underlying geomembranes if the geonet or geotextile is being cut in place.

5. Equipment used to deploy the geosynthetics shall not damage the materials or the underlying geomembrane.

6. No personnel working on the lining system shall smoke, wear damaging shoes, or engage in other activities that could damage the geosynthetics.

4.2 INSTALLATION

The Installer and QA Representative shall assure the following during geocomposite, geonet and geotextile seaming:

1. Overlap seams a minimum of six (6") inches.

2. Ties for the geonet are placed at three (3') foot intervals along the seam length. Only nylon ties which do not damage the underlying geomembrane are used; metal ties are not permitted.

3. Tying can be achieved by plastic fasteners. Tying devices shall be white or yellow for easy identification.

4. No horizontal seams are constructed on the side slopes.

5. For the geotextile component of the geocomposite sewing of the geotextile seam may be performed.

4.3 REPAIR PROCEDURES

Patching of the geonet shall be used to repair holes, tears, and defects. Patches shall provide 6" of overlap round the repaired area and shall be held in place with nylon ties. Geonet shall be removed if areas with large defects are observed. The QA Representative shall determine the acceptability of the geonet.

5.0 GEOSYNTHETIC ACCEPTANCE

5.1 INSTALLER

Installer retains all ownership and responsibilities for the geosynthetic until acceptance by the Owner.

5.2 OWNER

The Owner will accept geosynthetic installation when:

1. All required documentation from the Manufacturer and Installer has been received and approved.
2. The installation is complete.
3. Material conformance testing and destructive seam testing is complete.
4. Verification of the adequacy of all field seam and repairs, including associated testing, is complete.
5. Written certification documents, including drawings, sealed by a registered professional Engineer, have been received by RMC.
6. The Installer shall provide a final certification stating the installation has proceeded in accordance with the Specifications.

APPENDIX D

SAMPLING AND ANALYSIS PLAN

SAMPLING AND ANALYSIS PLAN
CORRECTIVE MEASURES IMPLEMENTATION
FORMER REFINED METALS CORPORATION FACILITY
BEECH GROVE, INDIANA

Prepared for:

REFINED METALS CORPORATION
Beech Grove, Indiana

Prepared by:

ADVANCED GEOSERVICES CORP.
West Chester, Pennsylvania

Project No. 2003-1046-18
October 6, 2010
Revised March 21, 2011

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LIST OF ATTACHMENTS

1.0 INTRODUCTION

The Sampling and Analysis Plan (SAP) presented in this attachment provides the policies, procedures, organization, objectives, functional activities, and specific Quality Assurance/ Quality Control (QA/QC) procedures that shall be employed by Refined Metals Corporation (RMC), Advanced GeoServices Corp. (Advanced GeoServices), and the Remedial Contractor during sampling associated with the proposed Corrective Measures for the RMC, Beech Grove, Indiana site to ensure that the technical data generated during the sampling are accurate and representative. This SAP provides the Quality Assurance Project Plan components.

1.1 SAMPLING AND ANALYSIS PLAN ORGANIZATION

Section 15.0 – Corrective Action

2.0 PROJECT DESCRIPTION

2.1 PROJECT BACKGROUND

The Refined Metals Corporation (RMC) Beech Grove facility (Site) was the location of a secondary lead smelting and refining operation from 1968 through 1995. The general location of the site is shown on Figure 1 of the CM Design Report and a detailed plan of the Site is shown on Sheet 1 of the design drawings. During its operational life, the facility handled hazardous materials or hazardous wastes under the Resource Conservation and Recovery Act (RCRA). These primarily consisted of lead acid automotive and industrial batteries, and lead-bearing materials that were processed for lead recovery.

In accordance with the requirements of RCRA, the facility completed and submitted a RCRA Part A permit application. On November 19, 1980 the facility was granted approval to operate two hazardous waste management units under Interim Status: 1) indoor waste piles; and 2) outdoor waste piles. Facility documents also identify a surface impoundment (lagoon) as a RCRA permitted unit; however, it does not appear to have been included on the Facility Part A permit until after 1991. The Surface Impoundment was, and still is, used to collect and manage facility storm water runoff. See Sheet 1 of the design drawings for the location of the RCRA Hazardous Waste Management Units (HWMUs).

The former indoor and outdoor waste piles were removed when normal facility operations ceased. The site sat idle after December 31, 1995 except for the wastewater treatment system which remained in operation to collect and manage storm water runoff from the lagoon and other site areas. Between August 2009 through early-January 2010 all buildings and structures were decontaminated and demolished, with the exception of four pump houses and the lagoon which were decontaminated, but remain in operation for on-site storm water management. Decontamination and demolition activities were performed in accordance with the *Draft*

Decontamination and Demolition Plan (Advanced GeoServices March 4, 2009) and the *Decontamination and Demolition Implementation Plan* (Focus Contracting, June 8, 2009) both of which were submitted, reviewed and approved by the USEPA and IDEM. A summary report of the decontamination and demolition activities is being prepared on a parallel track with preparation of this CM Design submission and will be included as an attachment to the Corrective Measures Completion Report to be provided following completion of the Corrective Measures.

Throughout the decontamination and demolition process storm water continued to be collected, treated as appropriate, and discharged to the City of Indianapolis POTW. Storm water sampling performed after completion of site cleaning activities has demonstrated that storm water from the lagoon and cleaned surface areas of the site can be discharged without requiring pre-treatment. In an effort to reduce the hydraulic loading on the POTW, the City of Indianapolis has requested that RMC cease discharge of the clean storm water to the sanitary sewer following completion of decontamination and demolition activities. At this time RMC has submitted a request for a "No Exposure Certification for Exclusion from NPDES Storm Water Permitting" to allow surface discharge of the storm water currently sent to the POTW. If storm water currently sent to the POTW will be surface discharged, it will most likely be sent to the drainage ditch at the north end of the property using the existing system of pumps and internal conveyance piping. RMC is also requesting approval from the City of Indianapolis to continue storm water discharge to the POTW until appropriate approvals for surface water discharge can be secured.

Additional background information is provided in CM Design Report Section 2.0. Previous soil sampling is discussed in CM Design Report Section 4.0.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

The overall responsibility for the project is assigned to Mr. Matthew Love of Exide Technologies, representative of RMC. In this capacity, Mr. Love is responsible for the overall performance of the project including ensuring that the project is conducted in accordance with the Consent Decree and the Corrective Measures (CM) Design Report. This includes confirming that the Contractor, the QA Representative, and the contracted laboratory all conduct its operations in compliance with the CM Design Report.

The remedial activities will be performed by a Contractor selected based on cost and qualifications.

Construction Quality Assurance (QA) oversight will be the responsibility of RMC. Construction Quality Assurance services are expected to be provided by Advanced GeoServices utilizing personnel experienced in construction and remediation projects.

While all personnel involved in an investigation and in the generation of data are implicitly a part of the overall project and quality assurance program, certain individuals have specifically delegated responsibilities. The Information Gathering activities will be performed by Advanced GeoServices, under the direction of RMC. The AGC personnel with quality assurance/quality control (QA/QC) responsibilities are the Project Manager, QA Official, QA Manager, QA Scientist, and the field technicians. For samples collected by AGC personnel and/or their subcontractors, the analyses of the samples will be performed by Test America in North Canton, Ohio. The laboratory retains the responsibility for analytical data quality assurance, however. Specific laboratory personnel with QA/QC responsibilities include the Laboratory QA Officer and Laboratory Sample Custodian.

When sampling activities will be conducted by the Contractor, the Contractor's personnel will be required to meet the enclosed requirements.

3.1 PROJECT MANAGER

The Project Manager is an experienced manager and technical professional who assists in the coordination of the CM, participates in major meetings and regulatory negotiations and provides upper level contact for the client. The designated Project Manager is Paul Stratman, P.E., P.G.

3.2 QA OFFICIAL

The QA Official will be experienced in construction and remediation projects. The QA Official will be responsible for verifying that the Contractor's Quality Control activities are implemented in accordance with the Final Corrective Measures Design, including the Construction Quality Assurance Plan (CQAP). The QA Official is also responsible for conducting the sampling components of the CQAP.

3.3 QA MANAGER

The QA Manager will work on all projects requiring the collection of data, and as such is not directly involved in the routine performance of the technical aspects of the investigations. The QA Manager's responsibilities include the development, evaluation, and implementation of the SAP and procedures appropriate to the investigation. Additional responsibilities include reviewing project plans and revising the plans to ensure proper QA is maintained. The QA Manager is also responsible for all data processing activities, data processing QC, and final analytical data quality review.

It is a major responsibility of the QA Manager to ensure that all personnel have a good understanding of the SAP, and understanding of their respective roles relative to one another, and an appreciation of the importance of the roles to the overall success of the program.

3.4 QA SCIENTIST

The QA Scientist has primary responsibility for analytical data validation and review. In this capacity, the QA Scientist will prepare data validation reports describing data usability and analytical QC problems encountered.

3.5 FIELD TECHNICIANS

Experienced AGC Field Technicians will conduct all sampling tasks to be conducted by AGC. Select sampling will be conducted by the Contractor. One of the Field Technicians will be designated as the Field Team Leader. Their responsibilities will include the documentation of the proper sample collection protocols, sample collection, field measurements, equipment decontamination, and logbook and CHOC documentation.

3.6 ANALYTICAL LABORATORY QA OFFICER

The QA Officer has the responsibility for maintenance of all laboratory QA activities and documentation. The laboratory's designated QA Manager has been included as part of the each laboratory's quality assurance manual (QAM). The QAM from Test America has been included as Attachment A.

3.7 ANALYTICAL LABORATORY SAMPLE CUSTODIAN

The Sample Custodian's responsibilities include ensuring proper sample entry and sample handling procedures by laboratory personnel.

4.0 QUALITY ASSURANCE/QUALITY CONTROL OBJECTIVES

Site activities performed by the project team at the Site will incorporate, but not be limited to, the QA/QC procedures established herein during the removal activities.

In combination, QA and QC represent a set of procedures designed to produce analytical data of known and acceptable quality. A useful distinction between QA and QC programs can be made as follows: the QC program ensures that all information, data, and decisions resulting from the investigation are technically sound and properly documented, while the QA program assures that the QC program achieve its goals.

Data Quality Objectives (DQOs) are quantitative and qualitative statements specifying the quality of the environmental data required to support the decision making process. Separate DQOs are designed for field sampling and laboratory analysis so that clear distinctions between any problems found in the system can be isolated with respect to cause. Conversely, the DQOs are also designed to provide an indication of the variability of the overall system. The overall QA objective is to keep the total uncertainty within an acceptable range that will not hinder the intended use of the data. To achieve this, specific data requirements such as detection limits, criteria for precision and accuracy, sample representativeness, data comparability and data completeness (PARCC) are specified below.

Project specific DQOs are provided in Table 2.

4.1 PRECISION

Precision measures the reproducibility of data or measurements under specific conditions. Precision is a quantitative measure of the variability of a group of data compared to their average value. Precision is usually stated in terms of relative percent difference (RPD) or relative standard deviation (RSD). Measurement of precision is dependent upon sampling technique and analytical method. Field duplicate and laboratory duplicate samples will be used to measure precision for project samples. Both sampling and analysis will be as consistent as possible. For a pair of measurements, the RPD will be used to evaluate precision. For a series of measurements, RSD will be used to evaluate precision. The total precision of a series of measurements can be related by the additive nature of the variances. Equations for RPD and RSD are presented in Section 14.1 of this SAP.

QC samples, including field and laboratory duplicate samples will be analyzed and used to monitor precision for this project. One field duplicate will be collected for every 20 soil samples. A matrix spike sample and laboratory duplicate sample will be collected at a frequency of one set per 20 samples per matrix. All duplicate results will be evaluated during data validation with respect to the applicable DQO criteria listed in Table 2 and the Region V Standard Operating Procedure for Validation of CLP Inorganic Data (USEPA, 1993).

Precision will be evaluated for all lead analyses performed in this program using the results of field and laboratory duplicate samples.

4.2 ACCURACY

Accuracy is defined as the degree of agreement of a measurement or average of measurements with an accepted reference value. Accuracy measures the bias in a measurement system which may result from sampling or analytical error. Sources of error that may contribute to poor accuracy are:

- laboratory error;
- sampling inconsistency;

- field and/or laboratory contamination;
- sample handling;
- matrix interference; and
- preservation.

Equipment blanks, as well as matrix spike (MS) QC samples, will be used to measure accuracy for project samples. The field component of accuracy will be negligible if the sampling, preservation, and handling techniques described in this SAP are followed. Accuracy in laboratory methods and procedures will be evaluated by use of calibration and calibration verification procedures, and instrument performance solutions, at the frequency specified in the USEPA "Test Methods for Evaluating Solid Waste Physical/Chemical Methods," November 1986, SW-846 3rd edition for lead analyses. Accuracy is calculated using the equation presented in Section 14.2 of this SAP.

Field and laboratory blanks, matrix spike samples and LCSs will be used to measure accuracy for the project samples. Blanks will be used to evaluate whether laboratory or field procedures represent a possible source of contamination. Equipment blanks will be collected one per 20 samples. Matrix spike samples and laboratory duplicates will be analyzed at a frequency of one pair per 20 samples. LCSs will be analyzed at a frequency of one per matrix per 20 samples or per laboratory preparation batch, whichever is more frequent. Accuracy will be evaluated based upon blank and spiked sample results with respect to the applicable DQO criteria listed in Table 2 and the Region V Standard Operating Procedure for Validation of CLP Inorganic Data (USEPA, 1993).

The laboratory method and calibration blanks will be required to meet specific criteria for compliance as listed in SW 846 methodology.

In the data validation, all blank samples will be evaluated. The general procedure for assessing blank samples will be as follows:

- Lead results will be reviewed for all blank samples collected outside of HWMUs.
- Antimony, arsenic, cadmium, lead and selenium results will be reviewed for all blank samples collected inside of HWMUs.
- All analytes will be reviewed for blank samples for groundwater monitoring.
- All blank samples for which lead is reported above the MDL will be identified.
- If contaminants are not detected in any of the blank samples, the data will be reported unqualified for blank contamination.
- If contaminants are found in any of the blank samples, the sample concentration(s) will be reported in the data validation narrative and assessed according to the Region V Standard Operating Procedure for Validation of CLP Inorganic Data (USEPA, 1993).

4.3 DATA REPRESENTATIVENESS

Representativeness expresses the degree to which sample data represent the characteristics of the environment from which they are collected. Samples that are considered representative are properly collected to accurately characterize the contamination at a sample location. Therefore, an adequate number of sampling locations have been chosen, and the samples will be collected in a standardized method. Representativeness will be measured by the collection of field duplicates. Comparison of the analytical results from field duplicates will provide a direct measure of individual sample representativeness.

Comparison of the analytical results from field duplicate samples will provide a direct measure of the representativeness of individual sample results. The RPDs of the field duplicate results will be compared to the project-specific DQOs as given in Table 2.

4.4 DATA COMPLETENESS

Completeness is defined as the percentage of data that is judged to be valid to achieve the objectives of the investigation compared to the total amount of data. Data gaps will be continuously addressed when/if they occur by systematic re-sampling, as needed. Deficiencies in the data may be due to sampling techniques, or poor accuracy, precision, and laboratory error. While deficiencies may affect certain aspects of the data, usable data may still be extracted from applicable samples. The level of completeness, with respect to usable data, will be measured during the data assessment process by comparing the total number of data points to the number of data points determined to be usable. A usability criteria of 90 percent has been set for this project. The equation used for completeness is presented in Section 14.3 of this SAP.

4.5 DATA COMPARABILITY

Comparability expresses the confidence with which one data set can be compared with another data set from a different phase or from a different program. Comparability involves a composite of the above parameters as well as design factors such as sampling and analytical protocols. Data comparability will be ensured by control of sample collection methodology, analytical methodology and data reporting.

4.6 SENSITIVITY

Analytical methods have been selected which can provide the DLs (sensitivity), accuracy and precision criteria defined for this project. Soil samples will be prepared according to USEPA's SW846 (USEPA, 1996) method 3050B, while all field and equipment blanks will be prepared according to SW846 3010A, both hot-acid digestion procedures. All samples will be analyzed using USEPA SW-846 Method 6010B (inductively couples plasma [ICP] spectroscopy), except for antimony, which will be analyzed using USEPA SW-846 Method 6020A.

Specific QLs are highly matrix-dependent and may not always be achievable. See Table 1 for parameters to be analyzed and the corresponding methods and DQO QLs.

4.7 PROCEDURES FOR MONITORING PARCC PARAMETERS

PARCC parameters will be monitored through the submission and analyses of various types of field and laboratory QC samples. These will include appropriate equipment blanks, laboratory method blanks, field duplicates, matrix spikes, and instrument performance solutions. See Table 2 for data quality objectives.

The frequency by which the field and laboratory QC samples will be prepared and submitted is specified in Section 6.9 of this SAP.

5.0 SAMPLING TO BE PERFORMED

This section presents the post excavation screening, stockpile sampling, confirmatory sampling, sampling during monitoring well installation, Containment Cell groundwater monitoring and MNA groundwater monitoring and analysis procedures to be performed by the QA Representative during CM implementation.

5.1 FIELD XRF SCREENING

During excavation activities within areas specifically designated for post-excavation confirmatory sampling, a portable, hand held XRF device will be utilized to aid in the vertical delineation, and in some cases horizontal delineation, of contaminated material exceeding the Post Remediation Goals (PRG) for the targeted site contaminants depending on the particular remediation area.

Confirmatory samples will be collected from 0 to 6 inch depth increment in the non-HWMU areas and from the 0-6 inch and 6 to 12 inch depth increment within the HWMUs. Samples will be placed in plastic bags, homogenized and the screened with the XRF. Five separate readings will be obtained on each sample, the results recorded and then averaged. Twenty percent of the XRF samples will be submitted for laboratory analysis and the results utilized to develop a correction factor for the other XRF results. Additional detail regarding development of the correction factor is provided in CQAP Appendix A. Laboratory analyses of Site metals shall be performed using EPA Method SW-846 6010B, except for antimony, which will be analyzed using EPA Method SW-846 6020A.

Additional detail regarding XRF screening is provided in CQAP Appendix A. Manufacturer's instructions for a typical XRF unit are provided in Attachment C of this document.

5.2 CONFIRMATORY SOIL AND SEDIMENT SAMPLING

Confirmation soil samples in both HWMU excavations and non-HWMU excavations will be consistent with the general protocol established for soil samples. Materials will be homogenized by mixing in the plastic baggies for at least one minute prior to XRF testing. Samples destined for laboratory analysis will be analyzed for lead only in non-HWMUs and Sb, As, Cd, Pb and Se in HWMUs. Areas that require additional excavation after the initial confirmation samples have been collected will be identified with the excavation depth. The results of all soil samples, including the XRF sampling results, XRF correlation samples, confirmation samples and duplicates will be entered into a computerized database.

The post-excavation confirmatory sampling program will be implemented by the QA Representative in areas to demonstrate attainment with the appropriate cleanup goals. A typical description of the XRF analysis is provided, but the actual XRF manufacturer instructions should be followed when performing the analysis.

The design and rationale for confirmatory soil and sediment sampling is provided in CQAP Appendix A. Additional detail regarding XRF sampling is provided in CQAP Appendix A.

5.3 STOCKPILE SAMPLING

During the course of the work, the Contractor will generate materials that may be clean relative to the remediation standards being applied to the project and suitable for reuse during restoration. The types of material will be primarily topsoil (stripped during construction of the containment cell and SWM basin), crushed concrete and masonry (resulting from demolition of remnant slabs, concrete pavements, structures and foundations). The work may also generate material suitable for use and structural soil fill or cap soil fill (Specification Section 02210) that the

Contractor wishes to have sampled for use as "unrestricted" material. All such materials shall be segregated based on type in stockpiles not exceeding 500 cy and characterized. Stockpile characterization shall be performed using composite samples. Stockpile sampling shall be performed as described in Section 6.2.

The design and rationale for stockpile sampling is provided in the CM Design Report.

5.4 AIR MONITORING

Air quality on-site sampling and personnel sampling will be conducted by the Contractor and monitored by the QA Representative. This SAP is not intended to cover air monitoring.

5.5 SAMPLING DURING WELL INSTALLATION

As discussed in CM Design Attachment H, MNA Work Plan, during installation of monitoring wells CC-1 through CC-6, at least two (2) soil samples will be collected for chemical analysis from each boring. The data will be used for geochemical modeling, if needed. The one sample each will be collected from the unsaturated overburden soils and from within the proposed screen horizon in each boring utilizing split spoon sampling techniques. Soil samples will be submitted for laboratory pH and eH, target analyte list (TAL) metals, arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), total organic carbon and sulfate. Samples from the same depth/intervals will also be submitted for gradation (sieve and hydrometer analysis).

5.6 CONTAINMENT CELL GROUNDWATER MONITORING

As discussed in CM Design Attachment E, Operation and Maintenance Plan, groundwater monitoring will be conducted at seven shallow groundwater monitoring wells to monitor the

Containment Cell. Wells CC-1 through CC-6 and MW-2 will be sampled at least once during CM implementation and once per quarter for seven quarters following the completion of CM implementation. Groundwater sampling will be performed semi-annually in the third and fourth years following completion of CM implementation and annually thereafter.

Groundwater samples will be analyzed for total and dissolved antimony, arsenic and lead, pH and total organic carbon. Field analysis will be conducted for pH, specific conductance, and turbidity.

Additional detail regarding Containment Cell groundwater monitoring is provided in CM Design Attachment E, Operations and Maintenance Plan. The design and rationale for Containment Cell groundwater monitoring is provided in CM Design Report Section 5.5.1 and Operations and Maintenance Plan Section 2.6 and 4.2.

5.7 MNA GROUNDWATER MONITORING

Existing wells MW-1, MW-2, MW-3, MW-8, MW-9 and MW-12 will be utilized as part of the MNA sampling network. In addition, the proposed monitoring wells CC-1 through CC-6 will serve the dual purpose of monitoring the containment cell and being part of the MNA sampling network.

The MNA groundwater monitoring wells will be sampled beginning approximately one month following installation of the proposed containment cell monitoring wells. Sampling will be performed once every calendar quarter for 12 consecutive quarters with the first evaluation regarding future frequency performed after completion of the second year of monitoring (i.e., after 8 quarters). Monitoring will end when the sampling results demonstrate that the remedial goals have been attained for four consecutive quarters. If analysis after the first 12 consecutive quarters indicates increasing concentrations, RMC will continue quarterly sampling while evaluating the observed results and developing an alternate strategy for mitigating impacts.

During the first two quarterly groundwater sampling events, samples will be analyzed for total and dissolved arsenic and lead, sulfide, sulfate, nitrate arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), and manganese speciation (MnII/MnVII) for use in geochemical modeling. Beginning after the second quarterly groundwater sampling event, groundwater analysis will be limited to total and dissolved lead and arsenic, unless additional geochemical modeling is deemed appropriate. Field parameter readings to be recorded at the time of sample collection during all groundwater sampling events shall include temperature; pH; Eh; dissolved oxygen (DO); specific conductance and turbidity.

Additional detail regarding MNA sampling is provided in CM Design Attachment H, MNA Work Plan. The design and rationale for MNA groundwater monitoring is provided in CM Design Report Section 5.5.2; Attachment E, Operations and Maintenance Plan Section 4.3; and Attachment H, MNA Work Plan.

6.0 SAMPLE COLLECTION PROCEDURES

6.1 CONFIRMATORY SAMPLE COLLECTION

Prior to sampling, loose soil or debris will be removed from the area using a stainless steel spoon or shovel or disposable scoops. Sampling implements will include stainless steel trowels or disposable plastic scoops, hand augering devices, and plastic Zip-Lock® baggies. Field personnel will don a new, clean pair of disposable gloves prior to sampling at each location. All implements, if not disposable, shall be decontaminated between the collection of each sample using the protocol described in this SAP. During the collection of each sample, the physical characteristics of the soil materials shall be recorded. Samples will be thoroughly mixed in a plastic bag for at least one minute. The plastic bag containing the homogenized sample will be labeled and entered on the Chain of Custody. Each soil sample will be of sufficient volume for subsequent analytical testing requirements as provided in Table 3.

Field personnel will record the soil's physical characteristics, a description of the sample location and depth, the time period for each sample collection, surface conditions surrounding the sample location, and all pertinent meteorological information.

6.2 STOCKPILE SAMPLING

Material stockpiles shall be characterized utilizing composite soil samples. The number of composite samples required to characterize a stockpile will be dictated by the estimated size of the pile. Each composite sample shall be comprised of 4 aliquots collected at various locations around the pile.

A detailed description of the sampling procedures is as follows:

A. Estimate the volume of the stockpile. The number of composite samples required is dictated by the estimated volume, as follows:

<250 cubic yards	-	1 Composite Sample
250 to 500 cubic yards	-	2 Composite Samples

B. Divide the stockpile into sections of equal volume based on the number of composite samples required. (i.e., piles <250 cy are treated as a single volume, a pile requiring 2 composite sample is divided in half). One composite sample will be collected from each section.

C. Provide each stockpile with a distinct identification and record the information (including type of material and source area) in the field book.

D. Evaluate the piles for consistency in the visual appearance (color, gradation, etc.) of the materials. Record any notable observations in the field book.

E. Subdivide each section into four quarters of roughly equal volume.

F. For piles that are determined to be relatively consistent (i.e. homogeneous) in visual appearance, collect 1 subsample (aliquot) from each quarter, biasing one sample towards the lower third of the pile, biasing another sample towards the upper third and collecting the remaining two samples from the middle third. In piles that are observed to be heterogeneous, utilize the quartering to dictate the distribution of subsamples around the pile but also target sampling to provide a proportional representation of the various materials in the pile. Collect all subsamples from a depth of greater than one foot below the pile surface.

G. Each aliquot in a stockpile shall have approximately equal volumes and shall be collected into a disposable aluminum tray. Remove large stones, sticks and vegetation. When sampling concrete rubble, the sampler should attempt to get a representative amount of the fines contained in the material after the crushing process and should remove those pieces larger than 1.5 inches.

H. Homogenize the sample by mixing in the aluminum tray until the composite is visually uniform using a disposable scoop and/or gloved hand.

I. Transfer an adequate volume of the composite sample to a glass or other approved sample container. The volume required for the sample is provided in Table 3. Cap and label the container, wipe residual from the outside of the container and complete require chain of custody. Collect duplicate and MS/MSD samples, as required below. Discard the remaining volume of material onto the stockpile.

J. Decontaminate reusable sample equipment following the procedures described below.

K. Place a stake marked with the stockpile identification and date sampled in the pile. Inform the Contractor when sample results are received and the final designation/disposition of the pile.

6.3 SOIL SAMPLING DURING MONITORING WELL INSTALLATION

Field personnel will don a new, clean pair of disposable gloves prior to sampling at each location. All implements, if not disposable, will be decontaminated between the collection of each sample using the protocol described in this SAP. The soil material from the desired interval will be removed from the split spoon using a disposable scoop or decontaminated trowel. The sample will be placed in a plastic bag.

During the collection of each sample, the physical characteristics of the soil materials shall be recorded. Samples will be thoroughly mixed in a plastic bag for at least one minute. The plastic bag containing the homogenized sample will be labeled and entered on the Chain of Custody. Each soil sample will be of sufficient volume for subsequent analytical testing requirements, as shown in Table 3.

Field personnel will record the soil's physical characteristics, a description of the sample location and depth, the time period for each sample collection, surface conditions surrounding the sample location, and all pertinent meteorological information.

6.4 SOIL SAMPLING DECONTAMINATION

The sampling methods prescribed herein have been developed to minimize the possibility of cross-contamination. Those sampling implements which cannot be decontaminated effectively shall be disposed of between and after sample collection. Decontamination procedures for sampling equipment will be as follows:

- Remove particulate matter and surface films with tap water, Alconox and brush as necessary;
- Deionized water rinse;
- Nitric acid rinse (0.1 N);
- Deionized water rinse;
- Air dry (if possible); and
- Cover with plastic or wrap in aluminum foil if stored overnight.

Equipment blanks will be collected for decontamination QC. A description of the types and frequency of QC samples is included in Section 6.9. Any deviations from these procedures will be documented in the field logbook.

All derived wastes from each sampling event will be returned to the ground in the direct vicinity of the sample collection point.

6.5 GROUNDWATER SAMPLING EQUIPMENT

The following equipment will be used for Containment Cell groundwater monitoring and MNA sampling:

- Low-flow bladder pump and control box;
- Flow through cell;
- Generator and/or nitrogen tank;
- Laboratory supplied containers for the collection of metals samples;
- Ice cooler for sample storage and transport;
- Ice;
- pH/temperature meter;
- Field Turbidity;
- Conductivity meter;
- Depth to water meter;
- Interface probe;
- Teflon® tubing; and,
- Disposable bailers.

6.6 GROUNDWATER SAMPLING PROCEDURES

The following sections describe groundwater sampling procedures for Containment Cell groundwater monitoring and MNA sampling. Well sampling is comprised of synoptic water level measurements, field analysis, well purge techniques, sample collection, and decontamination procedures as described in more detail below. Groundwater sampling will begin at the designated up-gradient monitoring well, then proceed to the next selected well with the lowest historical total metal concentration.

6.6.1 Synoptic Water Levels

Prior to all groundwater sampling events, depth-to-water will be measured in each well in general accordance with the American Society of Testing Materials (ASTM D 4750-97) procedures using an electronic water level indicator. The synoptic measurements will include the measurement of water levels and well depths in the monitoring wells in as short a time frame as possible to determine the piezometric surface across the Site. The field personnel will measure and record the water levels in the wells to the nearest 0.01 foot using the surveyed point at the top of the inner well casing for reference. Measurements will be repeated at each well until two consecutive readings are within 0.01 feet. Total depths will also be measured and recorded in each well after (to avoid suspension of settled solids) each sampling event to evaluate whether any silting of the well has occurred between sampling rounds. Water level measurements will be collected following IDEM Guidance Documents titled Collecting Static Water Level Measurements and Developing Ground Water Flow Maps. At the time of gauging the field technician will also make any notations regarding the condition of the wells (including unsecured, broken or missing locks).

6.6.2 Field Analyses

During Containment Cell groundwater monitoring, field measurements that will be performed during well purging will include pH, specific conductivity, and turbidity. During MNA sampling, field measurements that will be performed during well purging will include pH, eH, specific conductivity, temperature, dissolved oxygen (DO), and turbidity. Measurements will be collected by inserting the appropriate probe in a closed non-dedicated plastic container (flow-through-cell) that is rinsed with deionized water prior to purging the well. Turbidity samples will be collected from the flow through cell outflow.

Calibration of the instruments will be completed at the beginning of each sampling day, checked in the middle of the day, and as otherwise necessary based on the functioning of the meters and equipment. Each meter will be field calibrated in accordance with the manufacturer's specifications and appropriate calibration solutions. All calibrations will be recorded in the field log. Field calibration procedures at a minimum will include the following:

- Calibration of the field instruments will be performed by trained technicians prior to the mobilization of equipment to the Site. All the instruments will be calibrated as specified by the manufacturer. Standard solutions will also be checked to determine stability and operating conditions. All results of field calibrations and measurements will be maintained in bound field logbooks at least daily when the instrument is in use. The recorded calibration information will include date and time of calibration results.

- pH meters will be calibrated according to the manufacturer's instructions prior to each use and will, at a minimum, consist of two standard buffer solutions (pH 4, 7, or 10) obtained from chemical supply houses. The pH values of the buffers will be compensated for the temperature at which the pH sample is measured. Verification checks will be completed at least once per day using a standard solution. The verification check results must agree within ±0.05 pH standard units or re-calibrations will be performed.

- All temperature measurements will be measured using a field thermometer and recorded to ± 0.2°C.

- Dissolved oxygen meters will be calibrated to ambient air conditions.

- Specific conductance meters will be calibrated prior to each use using a potassium chloride solution (1,000 μmhos) prepared by a qualified laboratory or chemical supplier.

- Turbidity meters will be calibrated daily prior to use by a minimum of two standards of known turbidity as prepared by the manufacturer of the instrument. These solutions should bracket the levels found in the groundwater.

All calibration procedures performed will be documented in the field logbook and will include the date and time of calibration, name of the person performing the calibration, reference standards used and instrument readings. If equipment fails calibration or equipment malfunction is noted during calibration or use, the equipment will be tagged and removed from service.

6.6.3 Purging Procedures

Sampling procedures will include water level measurements, calculation of well volumes, purging, and sampling activities. The following step-by-step procedures are in adherence to the

EPA Region IX groundwater sampling protocols for low flow pump purging and sampling, which are based upon the method of Puls and Barcelona (EPA/540/S-9S/504). If a bladder pump cannot be inserted into a well due to bent riser piping, then a peristaltic pump will be used.

Step 1 Measure depth-to-water of every well at the Site.

Step 2 Calculate one well volume of the screened or open interval.

Step 3 Lower the low-flow pump to the mid-point of the screened interval.

Step 4 Calibrate meters.

Step 5 Begin to purge well. USEPA recommends a purge rate of 200 to 300 milliliters/minute (ml/min). The purge rate should not exceed the recharge rate (i.e., less than 0.3 feet of draw down from the static water level).

Step 6 Measure purging parameters at a minimum of one per well volume or every 3 to 5 minutes. Measurements will be collected via flow through cell for pH, temperature, specific conductivity, and DO. Turbidity will be measured at the outflow of the flow through cell every 3 to 5 minutes. All measurements will be recorded in the field logbook.

Step 7 After conductivity and temperature have stabilized to within 3% over three readings, pH readings differ <0.1 standard pH units, and turbidity measurements differ within ±10%, sampling can begin after the flow-through cell is disconnected.

Step 8 Using the well purging pump, the flow rate will be reduced to 100 ml/min and the unfiltered sample will be collected out of the discharge line. The date and time of the sample collection will be recorded in the field logbook.

Step 9 Using the well purging pump, the flow rate will remain at 100 ml/min and a disposable 0.45 micron in-line filter will be place at the discharge line. The filtered sample will be collected at the discharge end of the in-line filter. The date and time of the sample collection will be recorded in the field logbook. Filtering the samples in-line, as proposed, with disposable filters will reduce sample agitation, exposure to the atmosphere, and decontamination concerns.

Step 10 Following groundwater sample collection, measure depth-to-bottom of every well at Site.

Purge water will be collected and containerized in a drum. The pump and sampling equipment will be decontaminated before and between each well.

6.6.4 Sample Collection

Groundwater samples will be collected using the low flow pump or peristaltic pump and tubing at a rate of 100 ml/min with the flow-through cell disconnected. Groundwater will be collected directly into laboratory prepared bottles. As shown in Table 3, filtered groundwater samples will be collected in one-liter HDPE bottles that are preserved with nitric acid to a pH value of less than 2 standard units. All other samples will be collected in glass or HDPE bottles with the appropriate preservation. Immediately following sample collection and labeling of bottle, the sample will be placed in an ice cooler to maintain sample at 4° C.

6.6.5 Decontamination of Groundwater Sampling Equipment

The pump will be disassembled and components will be decontaminated in the following manner:

- Alconox and water wash;
- Potable water rinse;
- Nitric acid rinse (10% solution);
- Distilled water rinse; and,
- Air dry and store pump in plastic.

To prevent possible contamination from sampling equipment, all non-dedicated sampling devices will be decontaminated. Non-dedicated equipment is the low flow pump. Sampling equipment will be constructed of inert material (e.g., stainless, Teflon®). For non-dedicated equipment, field decontamination will be performed prior to its initial use, between sampling locations and between actual samples when more than one sample is to be collected at a given location. All non-dedicated sampling equipment will be decontaminated according to the following procedure:

1. Wash equipment thoroughly with a low phosphate detergent (Alconox) and water using a brush to remove any particulate matter or surface film.
2. Rinse equipment with distilled water.
3. Rinse with diluted nitric acid (10%N).
4. Triple rinse with distilled water.
5. Air dry equipment.
6. Wrap equipment in a clean plastic sleeve or in aluminum foil if not used immediately.

Spent nitric acid will be contained in buckets or drums. After the groundwater sampling activities are complete, the containerized decontamination water will be sampled and disposed of properly.

6.7 FIELD SAMPLING DOCUMENTATION PROCEDURES

Field sampling operations and procedures will be documented by on-site personnel in bound field logbooks. Where appropriate, field operations and procedures will be photographed. Documentation of sampling operations and procedures will include documenting:

- Procedures for preparation of reagents or supplies which become an integral part of the sample (e.g., preservatives and absorbing reagents);
- Procedures for recording the exact location and specific considerations associated with sampling acquisition;
- Specific sample preservation method;
- Calibration of field instruments;
- Submission of field-based blanks, where appropriate;
- Potential interferences present at the Site;
- Field sampling equipment and containers including specific identification numbers of equipment;
- Sampling order;
- Decontamination procedures; and
- Field personnel.

Field logbooks will be waterproof and bound. The logbook will be dedicated to the job. No pages will be removed. Corrections will be made by drawing a single line through the incorrect data and initialing and dating the correction that was made to the side of the error. An initialed diagonal line will be used to indicate the end of an entry or the end of the day's activities.

6.8 SAMPLE CONTAINERS AND PRESERVATION

Table 3 lists the appropriated sample containers, preservation methods, and holding times for sample analysis. Samples will be labeled in the field according to the procedures outlined in Section 7.0 of this Attachment.

6.9 QUALITY CONTROL SAMPLES

Field QA/QC samples will be collected to determine if contamination of samples has occurred in the field and, if possible, to quantify the extent of contamination so that data are not lost. Duplicate samples, equipment blanks and matrix spike/matrix spike duplicate (MS/MSD) samples will be collected. The duplicate QC samples will be labeled with distinct identification locations and times, and submitted to the laboratory as regular samples. The actual identification of the duplicate QC samples will be recorded in the field logbook.

A summary of the field QA/QC samples to be collected during the sampling program are presented as follows:

- Equipment blanks consisting of laboratory supplied deionized water poured over sampling equipment;
- Duplicate samples for the samples sent for laboratory analysis; and,
- Matrix spike.

6.9.1 Duplicate Samples

Duplicate samples are independent samples collected in such a manner that they are equally representative of the sampling point and parameters of interest at a given point in space and time. Field duplicate samples provide precision information of homogeneity, handling, shipping, storage, preparation and analysis. Field duplicate samples will be analyzed with the original field samples for the same parameters.

Soil sample duplicates will be collected and homogenized before being split. Groundwater samples will be obtained by alternately filling sample containers from the same sampling device for each parameter. One of every twenty samples submitted for laboratory analysis will be duplicated.

6.9.2 Equipment Blanks

The equipment (rinsate) blank is designed to address cross-contamination between sample sources in the field due to deficient field equipment decontamination procedures. This blank also addresses field preservation procedures, environmental Site interference and the integrity of the source water for field cleaning.

An equipment blank will be prepared during sampling when a particular piece of sampling equipment was employed for sample collection and subsequently decontaminated in the field for use in additional sampling. Preservatives or additives will be added to the equipment blank where appropriate for the sampling parameters.

For soil sampling, the equipment blank will be composed in the field by collecting, in the appropriate container for water, a blank water rinse from the equipment (spoon, auger, corer, etc.) after execution of the last step of the proper field decontamination protocol. One equipment blank will be collected per 20 soil samples collected outside of HWMUs and sent to the off-site lab for lead analysis. One equipment blank will be collected per 20 soil samples collected inside of HWMUs and sent to the off-site lab for antimony, arsenic, cadmium, lead and selenium analysis.

For groundwater sampling, the sampling equipment will be filled with deionized water or deionized water will be pumped through the device, and transferred to the appropriate container for water. One equipment blank will be collected per 20 groundwater samples and sent to the off-site lab. During Containment Cell groundwater monitoring, the equipment blank will be analyzed for total and dissolved antimony, arsenic, and lead, pH and total organic carbon.

During the first two MNA events, the equipment blank will be analyzed for total and dissolved arsenic and lead, sulfide, sulfate, nitrate, arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), and manganese speciation (MnII/MnVII). After the first two MNA events, the equipment blank will be analyzed for total and dissolved lead and arsenic. Equipment blanks for dissolved metals will be filtered through a 0.45 μm filter prior to preservation.

6.9.3 Matrix Spike Samples

Where required by the SAP, an Matrix Spike/Matrix Spike Duplicate (MS/MSD) will be collected and analyzed for the same parameters as the parent sample. MS and MSD samples determine accuracy by the recovery rates of the compounds added by the laboratory (the MS/MSD compounds are defined in the analytical methods). The MS samples also monitor any possible matrix effects specific to samples collected from the Site and the extraction/digestion efficiency. In addition, the analysis of MS/MSD samples check precision by comparison of the two spike recoveries.

To ensure sufficient soil sample volume, MS/MSD sample locations shall have a second soil volume collected from the same diameter and depth interval as the parent sample immediately adjacent to the parent sample location. Both soil volumes will be placed into the same baggies, composited together and analyzed with the XRF before being placed into separate baggies. Each sample will be labeled with the sample number as the parent sample, designated as an MS/MSD sample, and submitted to the laboratory for the appropriate analyses. One MS/MSD sample will be collected for every 20 investigative and duplicate soil samples collected and sent to the off-site lab for analysis.

For groundwater samples, MS/MSD samples will be collected from the same location as the field sample and in the same manner. One MS/MSD sample will be collected for every 20 groundwater samples.

6.9.4 Field Blanks

Field blanks are collected during groundwater sampling by pouring demonstrated analyte-free water provided by the laboratory from one sample container into a preserved sample container identical to those provided for sample collection. One field blank will be collected for each sampling round, and will be analyzed for the same parameters as the actual samples. Field blanks for dissolved metals will be filtered through a 0.45 μm filter prior to preservation.

7.0 SAMPLE CUSTODY

Sample identification and chain-of-custody shall be maintained for the work through the following chain-of-custody procedures and documentation:

- Sample labels, which prevent misidentification of samples;
- Custody seals to preserve the integrity of the sample from the time it is collected until it is opened in the laboratory;
- Field logbooks to record information about the site investigation and sample collection;
- Chain-of-Custody records to establish the documentation necessary to trace sample possession from the time of collection to laboratory analysis; and,
- Laboratory logbooks and analysis notebooks, which are maintained at the laboratory to record all pertinent information about the sample.

The purpose of these procedures is to ensure that the quality of the sample is maintained during its collection, transportation, storage and analysis. All sample control and chain-of-custody procedures applicable to the subcontracted laboratory will be presented in the laboratory's procedures.

7.1 CHAIN-OF-CUSTODY

A sample is in custody if it is in someone's physical possession or view, locked up or kept in a secure area that is restricted to authorized personnel.

7.1.1 Field Custody Procedures

As few persons as possible should handle samples in the field. The sample collector is personally responsible for the care and custody of samples collected until they are transferred to another person. The QA Representative will determine whether proper custody procedures were followed during field work and decide if additional samples are required.

7.1.2 Sample Labels

Identification labels are to be attached to the field sample containers. The labels shall not obscure any QA/QC lot numbers on the bottles. Sample information will be printed on the label in a legible manner using waterproof ink. The identification on the label must be sufficient to enable cross-reference with the logbook.

7.1.3 Chain-of-Custody

The chain-of-custody record must be completed by the person responsible for sample shipment to the subcontracting laboratory. All constraints on time and analytical procedures should be marked on the record. The custody record should also indicate any special preservation or filtering techniques required by the laboratory.

7.1.4 Transfer of Custody and Shipment

Chain-of-Custody records must be kept with the samples at all times. When transferring the samples, the parties relinquishing and receiving them must sign, date, and note the time on the record. Each shipment of samples to the laboratory must have its own chain-of-custody record with the contents of the shipment, method of shipment, name of courier, and other pertinent information written on the record. The original record accompanies the shipment and the copies are distributed to the Project Manager. Freight bills, Postal Service receipts and bills of lading are retained as permanent documentation.

7.1.5 Custody Seals

Custody seals are adhesive-backed seals with security slots designed to break if the seals are disturbed. Seals are placed on all shipping containers, and seals shall be signed and dated before use.

7.2 SAMPLE DESIGNATION

Samples collected from each location, shall be identified by using a standard label which is attached to the sample container. The following information shall be included on the sample label:

Site name;
Date and time of sample collections;
Designation of the sample (i.e., grab or composite);
Type of sample with brief description of sampling location (depth);
Signature of sampler;
Sample preservative used; and
General types of analyses to be conducted.

7.2.1 Proposed Sample Identification System

The following sample identification system will be utilized to identify the location, type and depth of each soil sample collected. The soil removal area identification will match the designations shown on the design drawings and the grid location will utilize an alpha-numeric designation developed by the QA Representative in consultation with the Contractor. Addition information will include depth of sample relative to pre-remediation ground surface.

Type of Sample	**ID/Depth/Date**
XRF Field Screening/Confirmation	XRF-FL4B/1.0-1.5-A5
Lab Analysis Confirmation	FL4B/1.0-1.5/A5
Duplicate	FL4B-D/1.0-1.5/A5
Stockpile Composite Sample	SP-1
Groundwater	CC-1 or MW-1

The results of all samples, including the XRF sampling results, XRF correlation samples, confirmation samples and duplicates will be entered into a computerized database. The database will be divided into sections labeled with each individual excavation identification and grid number and sub grid number.

7.3 SAMPLE HANDLING, PACKAGING, AND SHIPPING

Regulations for packaging, marking, labeling, and shipping hazardous materials are promulgated by the USDOT in the Code of Federal Regulations, 49 CFR 171 through 177. Samples obtained from the Site are anticipated to be environmental samples which are not expected to contain high levels of hazardous substances. Therefore, the shipment of samples designated as environmental samples are not regulated by DOT.

Samples collected by the QA Representative will be relinquished, directly to the laboratory, to the laboratory courier or shipped to the laboratories using the method described below. Environmental samples shall be packed prior to shipment by air using the following procedures:

Select a sturdy cooler in good repair. Secure and tape the drain plug with fiber or duct tape.

Allow sufficient outage (ullage) in all bottles to compensate for any pressure and temperature changes (approximately 10 percent of the volume of the container).

Be sure the lids on all bottles are tight (will not leak), and baggies are sealed.

Line coolers with minimum of two large trash bags. Place samples inside of lined coolers. Put ice on top of or between the samples. Pack samples securely to eliminate breakage during shipment. Tie off trash bags to seal.

Place chain-of-custody into a plastic bag, tape the bag to the inner side of the cooler lid and then close the cooler and securely tape (preferably with fiber tape) the top of the cooler shut. Custody seals should be affixed to the top and side of the cooler so that the cooler cannot be opened without breaking the seal.

A label containing the name and address of the shipper shall be placed on the outside of the container.

7.4 SAMPLE PRESERVATION AND HOLDING TIMES

When needed, sample containers will be obtained from the subcontracting laboratory and shall be prepared with a predetermined amount of preservative for each specified sample unless otherwise stated in the site specific field plan. A list of preservatives and holding times for each type of analysis are included Table 3 of this Attachment.

7.5 LABORATORY SAMPLE CUSTODY PROCEDURES

Once the sample arrives at the laboratory, custody of the samples will be maintained by laboratory personnel. Upon receipt of the samples, the sample receipt personnel will remove the chain-of-custody from the sealed cooler and sign and record the date and time on the chain-of-custody. The samples received will be verified to match those listed on the chain-of-custody. The laboratory will document and notify the sample generators QA Manager immediately if any inconsistencies exist in the paperwork associated with the samples. The laboratory at a minimum will document the following stages of analysis: sample receipt, sample extraction/preparation, sample analysis, data reduction, and data reporting.

Samples will be given a unique laboratory identification number and logged into the Laboratory Information Management System (LIMS). The analyst will enter the analytical data into the LIMS upon analysis completion and validation. The LIMS tracks the sample until completion of the report and invoice mailing. The data archived from the LIMS will be transferred to electronic storage format and retained for five years from the completion of sample analysis.

8.0 CALIBRATION PROCEDURES AND FREQUENCY

All instruments and equipment used during sampling and analysis will be operated, calibrated, and maintained according to the manufacturer's guidelines and recommendations. Operation, calibration and maintenance will be performed by trained personnel on a daily basis. All maintenance and calibration information will be documented and will be available upon request.

Manufacturer's instructions for the XRF unit are provided in Attachment C.

9.0 LABORATORY QUALITY ASSURANCE PROGRAM

Samples will be analyzed by Test America in North Canton. The Test America quality assurance program is provided as Attachment A. The quality assurance program documents include the following:

- Title page;
- Table of contents;
- QA policy statement;
- Laboratory organization and responsibility;
- Sampling procedures and equipment;
- Sample custody;
- Data reduction, validation, and reporting;
- Performance and systems audit;
- Preventive maintenance;
- Corrective action; and
- Resumes.

10.0 DATA REDUCTION, VALIDATION AND REPORTING

10.1 DATA REDUCTION

All analytical data will be permanent, complete and retrievable. The analyst will enter the analytical data into the LIMS upon analysis completion and laboratory validation. The laboratory will report sample results on analysis report forms and provide the information referenced in the USEPA Methods for each deliverables package. All laboratory data will undergo the data validation procedures described in the Laboratory QA Manual prior to final reporting. Data will be stored on the laboratory's network until the investigation is complete and data archived from the LIMS will be transferred to magnetic tape which will be retained by the laboratory for an additional five years.

Results will be reported in micrograms per liter (ug/l) for aqueous samples or milligrams per kilogram (mg/kg) for solid samples. Equations to calculate concentrations are found in the SW-846 Method 6010B and 6020A. All blank results and QC data will be included in the data deliverables package. Blank results will not be subtracted from the sample results. The blank results and QC data will be used in data validation to review sample results qualitatively. Data validation will be performed for samples analyzed at the off-site laboratory in general accordance with the guidelines identified in Section 10.2. Outliers and other questionable data will be addressed in the data validation report and specific QA/QC flags will be applied to questionable data. The QA/QC flags will be consistent with the USEPA data validation guidelines.

All analytical data, reports, and any other project related information produced during this project will be stored in the project file at the sample generators office maintained by the Project Manager. Project reports, tables, etc. will be stored in project specific electronic files.

10.2 DATA VALIDATION PROTOCOL

Validation of analytical data as received from the off-site laboratory will be performed by an AGC QA Scientist. All data will be validated. Validation will be performed in general accordance with the following data validation guidance documents, where applicable:

- National Functional Guidelines for Inorganic Data Review, Multi-Media, Multi-Concentration. USEPA, February 1994.

- Region V Standard Operating Procedures for Validation of CLP Inorganic Data, USEPA, September 1993.

A detailed QA review will be performed on all data by the AGC QA Scientist to verify the qualitative and quantitative reliability of the data as it is presented. This review will include a detailed review and interpretation of all data generated by the laboratory. The primary tools which will be used by the AGC QA Scientist will be guidance documents, established (contractual) criteria, and professional judgement. The items that will be examined during the detailed QA review of data will consist of: sample results; analytical holding times; sample receipt condition, preservation, and cooler temperature; chains-of-custody; initial and continuing calibrations; CDRL standards; blanks (method, preparation, initial, continuing, and equipment; ICP interference check samples; surrogates; laboratory duplicates; field duplicates; internal standards; MS/MSD recoveries; laboratory control samples; serial dilutions; blank spikes; furnace QC components (post digestion spikes; MSA; correlation coefficients); GC/ECD instrument performance checks; target compound identification; and overall system performance. A typical data validation checklist is provided in Attachment B.

Based upon the detailed review of the analytical data, a data validation report will be prepared which will state in a technical, yet "user-friendly" fashion the qualitative and quantitative reliability of the analytical data. The report will consist of an introduction section, followed by qualifying statements that should be taken into consideration for the analytical results to best be utilized. Based on the QA review, qualifier codes will be placed next to specific sample results on the sample data tables, if necessary. These qualifier codes will serve as an indication of the qualitative and quantitative reliability of the data. Common qualifier codes include:

- "U" – the analyte was not detected at or above the reporting limit;
- "J" – the analyte was positively identified and detected; however, the concentration is an estimated value because the result is less than the reporting limit or quality control criteria were not met;
- "UJ" – the analyte was not detected, the associated reporting limit is an estimated value;
- "R" – data are rejected due to significant exceedance of quality control criteria. The analyte may or may not be present. Additional sampling and analysis are required to determine;
- "D" – value was obtained from reanalysis of a diluted sample;
- "DJ" – the analyte was positively identified and detected; however, the concentration is an estimated value because quality control criteria were not met *and* the value was obtained from reanalysis of a diluted sample;
- "B" – not detected substantially above the level reported in laboratory or field blanks;
- "K" – analyte present. Reported value may be biased high. Actual value is expected lower; and,
- "L" – analyte present. Reported value may be biased low. Actual value is expected to be higher.

Once the review has been completed, the AGC QA Manager will verify the accuracy of the review and will then submit these data to the AGC Project Manager. The QA Manager or designated individual will check 100% of assigned qualifiers and other hand entered items. These approved data tables and data validation reports will be signed and dated by the AGC QA Manager.

10.3 DATA VALIDATION REPORTS

Data validation reports, along with copies of all support documentation, validated data summary tables, and analytical data packages, will be submitted periodically as data are validated. Reports will be held for the duration of the project plus 5 years, at a minimum.

10.4 DATA REPORTING

All data deliverables from each laboratory must be paginated in ascending order. The laboratory must keep a copy of the paginated package in order to be able to respond efficiently to data validation inquiries. Any errors in reporting identified during the data validation process must be corrected by the laboratory as requested. All data validation inquiries to the laboratory must be addressed by a written response from the laboratory in question. The data deliverable required for this project will include a case narrative, the sample results (Form 1s), blank data, MS/MSD percent recoveries and relative percent differences, laboratory control sample percent recoveries, and any other quality control data.

11.0 INTERNAL LABORATORY QUALITY CONTROL CHECK SAMPLES AND CALCULATIONS

All QC procedures employed by the laboratory will be, at a minimum, equivalent to those required in the specified analytical methods. Laboratory QC checks are accomplished through the analyses of laboratory blanks, calibration verifications, laboratory control standards and performance evaluation samples. When internal QC results fall outside method acceptance criteria, the data will be reported, and the analysis repeated, flagged or accepted according to the specified analytical methods. The following sections describe internal laboratory QC check samples.

11.1 LABORATORY BLANKS

Method blanks are generated within the laboratory during the processing of the actual samples. These blanks will be prepared using the same reagents and procedures and at the same time as the project samples are being analyzed. If contamination is found in the method blank, it indicates that similar contamination found in associated samples may have been introduced in the laboratory and may not have been actually present in the samples themselves. Guidelines for accepting or rejecting data based on the level of contamination found in the method blank are presented in the specified analytical method.

A minimum of one method blank per 20 samples will be analyzed or, in the event that an analytical round consists of less than 20 samples, one method blank sample will be analyzed per round.

11.2 MATRIX SPIKE/MATRIX SPIKE DUPLICATES

MS analyses are performed in association with metal analyses. MS are prepared by placing a known quantity of selected target analytes into a second aliquot of an actual field sample. The spiking occurs prior to sample preparation and analysis. The MS is then processed in a manner identical to the field sample. Recovery of each of the spiked compounds reflects the ability of the laboratory and method to accurately determine the quantity of that analyte in that particular sample.

11.3 LABORATORY CONTROL SAMPLE

The Laboratory Control Sample (LCS) is prepared by the laboratory by adding analytes of known concentrations to solution (DI water for metals analysis) for analyses. The LCS is prepared, analyzed and reported once per sample delivery group (SDG). The LCS must be prepared and analyzed concurrently with the samples in the SDG using the same instrumentation as the samples in the SDG. The LCS is designed to access (on a SDG-by-SDG basis) the capability of the laboratory to perform the analytical methods. If the analytes present in the LCS are not recovered within the criteria defined in the specified analytical methods, the samples will be reanalyzed or data will be flagged.

12.0 PERFORMANCE AND SYSTEM AUDITS

12.1 LABORATORY AUDITS

The purpose of a quality assurance audit is to provide an objective, independent assessment of a measurement effort. The quality assurance audit ensures that the laboratory's data generating, data gathering, and measurement activities produce reliable and valid results. There are two forms of quality assurance audits: performance evaluation audits and system audits.

12.1.1 Performance Evaluation Audits

The purpose of performance evaluation audits is to quantitatively measure the quality of the data. These audits provide a direct evaluation of the various measurement systems' capabilities to generate quality data.

The laboratory regularly participates in performance evaluation audits as part of their laboratory certification efforts. Performance audits are conducted by introducing control samples in addition to those routinely used.

The results of the performance audits are summarized and maintained by the Laboratory QA Supervisor and distributed to the section supervisors who must investigate and respond to any out of control results.

12.1.2 Technical System Audits

A technical systems audit is an on-site, qualitative review of the various aspects of a total sampling and/or analytical system. The purpose of the technical systems audit is to assess the overall effectiveness, through an objective evaluation, of a set of interactive systems with respect to strength, deficiencies, and potential areas of concern. Typically, the audit consists of observations and documentation of all aspects of sample analyses. External and internal audits are conducted of the laboratory throughout each year.

13.0 PREVENTATIVE MAINTENANCE

13.1 FIELD EQUIPMENT

Field measurement equipment and the XRF unit will be maintained in accordance with manufacturer's instructions. All field equipment will be checked by qualified technicians prior to use in the field. The instrument operator will be responsible for ensuring that the equipment is operating properly prior to use in the field. Any problems encountered while operating the instrument will be documented in the field logbook. If problem equipment is detected or should require service, the equipment will be returned and a qualified technician will perform the maintenance required. Use of the instrument will not be resumed until the problem is resolved. Routine maintenance of field instruments will be documented in the field logbooks.

13.2 LABORATORY EQUIPMENT

Preventative maintenance and periodic maintenance is performed as recommended by the manufacturers of the equipment in use in the laboratory. Spare parts are kept in inventory to allow for minor maintenance. Service contracts are maintained for most major instruments, balances and critical equipment. If an instrument fails, the problem will be diagnosed as quickly as possible, and either replacement parts will be ordered or a service call will be placed.

Laboratory logbooks are kept by the laboratory to track the performance maintenance history of all major pieces of equipment. The instrument maintenance logbooks are available for review upon request. Specific details of preventative maintenance programs for the laboratory will be provided in the Laboratory QA Manual.

14.0 SPECIFIC ROUTINE PROCEDURES USED TO ASSESS DATA PRECISION, ACCURACY AND COMPLETENESS

14.1 PRECISION

The precision of laboratory test results will be expressed as RPD or RSD. RPD is derived from the absolute difference between duplicate analyses divided by the mean value of the duplicates. The percent RSD is obtained by dividing the standard deviation by X. Equations for RPD and RSD are presented below:

$$RPD = \frac{|D1 - D2|}{(D1 + D2)/2} \times 100$$

Where:

D1 and D2 = the two replicate values

$$RSD = \frac{S}{X}; \text{ and } S = [n\,(x_i - x)^2/n-1]^{1/2}$$

i-1

Where:

S	=	standard deviation
x_i	=	each observed value
x	=	the arithmetic mean of all observed values
n	=	total number of values

14.2 ACCURACY

Accuracy will be calculated on the average percent recovery of spiked samples. Reference materials are essential to the evaluation of accuracy. Stock solutions for accuracy spikes and QC standards (if possible) shall be traceable to a source independent from the calibration standards. Accuracy is calculated using the following equation:

$$\%R = \frac{SSR - SR}{SA} = 100$$

Where:

%R	=	% recovery
SSR	=	spike sample result
SR	=	sample result
SA	=	amount of spike

14.3 DATA COMPLETENESS

Completeness is evaluated by dividing the total number of verifiable data points by the maximum number of data points possible and expressing the ratio as a percent. A usability criteria of 90 percent has been set for this project. The equation used for completeness is presented below:

$$C\ (\%) = \frac{D}{P \times n} \times 100$$

Where:

D	=	number of confident quantifications
P	=	number of analytical parameters per sample requested for analysis
n	=	number of samples requested for analysis

15.0 CORRECTIVE ACTION

When field sampling activities or laboratory QC results show the need for corrective action, immediate action will take place and will be properly documented. In the event that a problem arises, corrective action will be implemented. Any error or problem will be corrected by an appropriate action which may include:

- Replacing or repairing a faulty measurement system;
- Discarding erroneous data;
- Collecting new data; and
- Accepting the data and acknowledging a level of uncertainty.

15.1 FIELD SAMPLING CORRECTIVE ACTION

The on-site Principle Investigator will be responsible for all field QA. Any out of protocol occurrence discovered during field sampling will be documented in the field logbook and immediate corrective action will be taken. For problems or situations which cannot be solved through immediate corrective action, the Principle Investigator will immediately notify the AGC Project Manager. The AGC Project Manager and Principle Investigator will investigate the situation and determine who will be responsible for implementing the corrective action. Corrective action will be implemented upon approval by the AGC Project Manager. The Project Manager will verify that the corrective action has been taken, appears effective, and at a later date, verify that the problem has been resolved. The successfully implemented corrective action will be documented in the field logbook by the on-site Principle Investigator. Any deviations from the QA protocol in the SAP must be justified, approved by the AGC Project Manager (and IDEM and the USEPA, if necessary), and properly documented.

15.2 LABORATORY SITUATION CORRECTIVE ACTION

Corrective action will be implemented to correct discrepancies found which affect the validity or quality of analytical data, and to identify any analytical data that may have been affected. Limits of data acceptability for each parameter and sample matrix are addressed in the instrument manuals, USEPA Methods and/or Laboratory QA Manual. Whenever possible, immediate corrective action procedures will be employed. All analyst corrective actions are to be followed according to the instrument manuals, USEPA Methods, or Laboratory QA Manual. Any corrective action performed by the analyst will be noted in laboratory logbooks.

Laboratory personnel noting a situation or problem which cannot be solved through immediate corrective action will notify the Laboratory QA Supervisor. The QA Supervisor will investigate the extent of the problem and its effect on the analytical data generated while the deficiency existed. All data suspected of being affected will be scrutinized to determine the impact of the problem on the quality of the data. If it is determined that the deficiency had no impact on the data, this finding will be documented. If the quality of the analytical data were affected, the Laboratory Program Manager and the sample generator's Project Manager will be notified immediately so that courses of action may be identified to determine how to rectify the situation.

The laboratory must take corrective action if any of the QC data generated during the laboratory analyses are outside of the method criteria. Corrective action for out-of-control calibrations is to recalibrate the instrument and re-analyze the samples. A sequence is specified in the USEPA specified methods when problems in analyses are encountered. The laboratory will follow these procedures exactly and document the problems encountered and the corrective action in a case narrative enclosed with each data deliverables package.

The Laboratory QA Supervisor will be responsible for informing the Laboratory Program Manager and sample generator's Project Manager of the effects on the data, the data affected and the corrective action taken. It is also the Laboratory QA Supervisor's responsibility to verify that the corrective action was performed, appears effective, and at a later date, the problem was resolved.

15.3 DATA VALIDATION QA CORRECTIVE ACTION

Upon completion, sample data packages will be sent from the laboratory to the sample generator's QA Scientist for data validation. If all project samples are not present in the data packages or any deficiencies affecting the sample results are noted, the QA Scientist will contact the Laboratory QA Supervisor. The Laboratory QA Supervisor will respond in writing to any inquiries and provide any changes to the data packages to the QA Scientist. Any errors, problems, questionable data values, or data values outside of established control limits will be corrected by the appropriate action which may include disregarding erroneous data, collecting new data, and accepting the data and acknowledging a level of uncertainty. The data validation report will provide a description of the usability of the data.

TABLE 1
SAMPLING PARAMETERS AND REPORTING LIMITS
RMC Beechgrove, Indiana

LOCATION	MATRIX	METHOD	PARAMETER	RL	DQO	UNITS
HWMU	Soil/Sediment	SW-846 6020A[1]	Antimony	0.2	37	mg/kg
		SW-846 6010B[1]	Arsenic	1	20	mg/kg
			Cadmium	0.5	77	mg/kg
			Lead	0.3	970	mg/kg
			Selenium	0.5	53	mg/kg
outside HWMU, but still onsite		SW-846 6010B[1]	Lead	0.3	920	mg/kg
Offsite		SW-846 6010B[1]	Lead	0.3	400	mg/kg
Monitoring Well Installation		SW-846 9045	pH	NA	NA	S.U.
		US EPA 2480D	eH	20	NA	millivolts
		SW-846 6020A	Antimony	0.2	37	mg/kg
		SW-846 6010B	Aluminum	20	NA	mg/kg
			Arsenic	1	20	mg/kg
			Barium	20	NA	mg/kg
			Beryllium	0.5	NA	mg/kg
			Cadmium	0.5	77	mg/kg
			Calcium	500	NA	mg/kg
			Chromium	1	NA	mg/kg
			Cobalt	5	NA	mg/kg
			Copper	2.5	NA	mg/kg
			Iron	10	NA	mg/kg
			Lead	0.3	970	mg/kg
			Magnesium	500	NA	mg/kg
			Manganese	1.5	NA	mg/kg
			Nickel	4	NA	mg/kg
			Potassium	500	NA	mg/kg
			Selenium	0.5	53	mg/kg
			Silver	1	NA	mg/kg
			Sodium	500	NA	mg/kg
			Thallium	1	NA	mg/kg
			Vanadium	5	NA	mg/kg
			Zinc	5	NA	mg/kg
		SW-846 7471	Mercury	0.1	NA	mg/kg
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	0.4	NA	mg/kg
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	0.5	NA	mg/kg
		Walkley Black	Total Organic Carbon	1000	NA	mg/kg
		SW-846 9056	Sulfate	10	NA	mg/kg
		ASTM D422-63	Gradation (Sieve and Hydrometer)	NA	NA	NA

TABLE 1
SAMPLING PARAMETERS AND REPORTING LIMITS
RMC Beechgrove, Indiana

LOCATION	MATRIX	METHOD	PARAMETER	RL	DQO	UNITS
Containment Cell Monitoring	Aqueous	SW-846 6010B	Total and Dissolved Lead	1	15	µg/L
			Total and Dissolved Arsenic	1	10	µg/L
		SW-846 6020A	Total and Dissolved Antimony	2	6	µg/L
		SW-846 9040	pH	NA	NA	S.U.
		SW-846 9060	Total Organic Carbon	1	NA	mg/L
MNA	Aqueous	SW-846 6010B	Total and Dissolved Lead	1	15	µg/L
			Total Iron	50	NA	µg/L
			Total and Dissolved Arsenic	1	10	µg/L
		SW-846 9034	Sulfide	3	NA	mg/L
		SM 4500 SO3 B	Sulfite	5	NA	mg/L
		US EPA 300.0	Nitrate	0.1	NA	mg/L
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	2	10	µg/L
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	50	NA	µg/L
		Applied Speciated propriatary method	Manganese speciation (MnII/MnVII)	NA	NA	µg/L
Equipment Blanks	Aqueous	SW-846 6020A[1]	Total and Dissolved Antimony	2	NA	µg/L
		SW-846 6010B[1]	Total and Dissolved Arsenic	1	NA	µg/L
			Total Cadmium	1	NA	µg/L
			Total Iron	50	NA	µg/L
			Total and Dissolved Lead	1	NA	µg/L
			Total Selenium	5	NA	µg/L
		SW-846 9040	pH	NA	NA	S.U.
		SW-846 9060	Total Organic Carbon	1	NA	µg/L
		SW-846-9034	Sulfide	3	NA	µg/L
		SM 4500 SO3 B	Sulfite	5	NA	µg/L
		US EPA 300.0	Nitrate	0.1	NA	µg/L
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	2	NA	µg/L
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	50	NA	µg/L
		Applied Speciated propriatary method	Manganese speciation (MnII/MnVII)	NA	NA	µg/L

Notes:
Antimony will be analyzed by SW-846 6020A
µg/L: micrograms per liter — RL: Reporting Limit
mg/L: milligrams per liter — DQO: Data Quality Objective
mg/kg: milligrams per kilogram — N/A: not applicable

[1]USEPA "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", Feb. 2007, SW-846, 6th Revision.

TABLE 3
SAMPLE CONTAINERS, PRESERVATIVES, AND HOLDING TIMES
RMC Beechgrove, Indiana

LOCATION	MATRIX	METHOD	PARAMETER	CONTAINER	PRESERVATIVE	HOLDING TIME	MINIMUM SAMPLE VOLUME
HWMU Areas	Soil/Sediment	SW-846 6010B[1] SW-846 6020A (antimony)	Antimony, Arsenic, Cadmium, Lead, Selenium	zip lock baggies	none	6 months	5 grams
Non-HWMU Onsite Areas	Soil/Sediment	SW-846 6010B[1]	Lead	zip lock baggies	none	6 months	5 grams
Offsite Areas	Soil/Sediment	SW-846 6010B[1]	Lead	zip lock baggies	none	6 months	5 grams
Monitoring Well Installation	Soil/Sediment	SW-846 9045	pH	2 oz WMG	none	ASAP	10 grams
		US EPA 2580D	eH	8 oz WMG	none	none	25 grams
		SW-846 6010B SW-846 6020A (Antimony)	TAL metals	4 oz WMG or zip lock baggies	none	6 months 28 days (Mercury)	5 grams
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	4 oz WMG	none	28 days	5-10 grams
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	4 oz WMG	none	24 hours	10 grams
		Walkley Black	Total Organic Carbon	4 oz WMG	none	28 days	5 grams
		SW-846 9056	Sulfate	4 oz WMG	none	28 days	50 grams
		ASTM D422-63	Gradation (Sieve and Hydrometer)	1 L WMG	none	none	125 grams
Containment Cell Monitoring	Aqueous	SW-846 6010B	Total and Dissolved Lead	500 mL HDPE	HNO_3 pH<2; cool 4°C (total) cool 4°C (dissolved)	6 months	100 mL
		SW-846 6010B	Total and Dissolved Arsenic				
		SW-846 6020A	Total and Dissolved Antimony				
		SW-846 9040	pH	250 mL HDPE	cool 4°C	ASAP	100 mL
		SW-846 9060	Total Organic Carbon	500 mL amber	H_2SO_4, cool 4°C	28 days	40 mL
MNA	Aqueous	SW-846 6010B	Total and Dissolved Lead	500 mL HDPE	HNO_3 pH<2; cool 4°C (total) cool 4°C (dissolved)	6 months	100 mL
		SW-846 6010B	Total and Dissolved Arsenic				
		SW-846 9034	Sulfide	500 mL HDPE	Zn acetate/NaOH, cool 4°C	7 days	100 mL
		SM 4500 SO3 B	Sulfite	250 mL HDPE	cool 4°C	ASAP	100 mL
		US EPA 300.0	Nitrate	250 mL HDPE	cool 4°C	48 hours	100 mL
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	1 L HDPE	HCl, cool 4°C	28 days	100 mL
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	250 mL HDPE	cool 4°C	24 hours	50 mL
		Applied Speciation propriatary method	Manganese speciation (MnII/MnVII)	40 mL amber	cool 4°C	48 hours	40 mL
Equipment Blanks	Aqueous	SW-846 6010B[1] SW-846 6020A (antimony)	Total Antimony, Arsenic, Cadmium, Lead, Selenium	500 mL HDPE	HNO_3 pH<2; cool 4°C	6 months	100 mL
		SW-846 6010B[1] SW-846 6020A (antimony)	Dissolved Arsenic, Antimony, Lead	500 mL HDPE	cool 4°C	6 months	100 mL
		SW-846 9040	pH	250 mL HDPE	cool 4°C	ASAP	100 mL
		SW-846 9060	Total Organic Carbon	500 mL amber	H_2SO_4, cool 4°C	28 days	40 mL
		SW-846 9034	Sulfide	500 mL HDPE	Zn acetate/NaOH, cool 4°C	7 days	100 mL
		SM 4500 SO3 B	Sulfite	250 mL HDPE	cool 4°C	ASAP	100 mL
		US EPA 300.0	Nitrate	250 mL HDPE	cool 4°C	48 hours	100 mL
		US EPA 7063 mod	Arsenic speciation (arsenite/arsenate)	1 L HDPE	HCl, cool 4°C	28 days	100 mL
		SM 3500 Fe D	Iron speciation (ferric/ferrous)	250 mL HDPE	cool 4°C	24 hours	50 mL
		Applied Speciation propriatary method	Manganese speciation (MnII/MnVII)	40 mL amber	cool 4°C	48 hours	40 mL

[1]USEPA "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods", Feb. 2007, SW-846, 6th Revision.
HDPE - high density polyethylene
WMG - wide mouth glass jar
ASAP - as soon as possible

ATTACHMENT H

Monitored Natural Attenuation Work Plan Replacement Pages

MONITORED NATURAL ATTENUATION WORK PLAN

Prepared For:

REFINED METALS CORPORATION
Beech Grove, Indiana

Prepared By:

ADVANCED GEOSERVICES
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APPENDIX

1.0 PURPOSE

This Monitored Natural Attenuation Work Plan (MNA Work Plan) is intended to present a description of the Hydrogeologic Conceptual Site Model; a summation of sampling results for the shallow perched groundwater zone as observed during the RCRA Facility Investigation (RFI) and Closure Investigation; proposed MNA data collection requirements; and procedures for MNA data evaluation and reporting at the former Refined Metals Corporation (RMC) facility located on South Arlington Avenue in Beech Grove, Indiana. This MNA Work Plan is intended to provide supplemental information specific to groundwater as an Attachment to the Corrective Measures Design (CMD) Report.

As discussed in Section 5.0 of the CMD Report and specified in the Media Cleanup Standards section of the Statement of Basis (USEPA, June 2008), the corrective measure for the RMC facility will involve the excavation of soil and sediment with the highest lead and arsenic concentrations and consolidation within a containment cell with a low-permeability cover, and MNA of shallow perched groundwater. The proposed soil and sediment excavation activities being performed as part of the Corrective Measures will involve the removal of approximately 6,000 cubic yards of on-site material and achieve a Preliminary Remediation Goal for lead of 920 mg/kg. As part of the Hazardous Waste Management Unit (HWMU) Closure, nearly 5,000 cubic yards of soil will be remediated to achieve the post remediation level of 970 mg/kg for lead and 20 mg/kg for arsenic, as well as the IDEM RISC Industrial Closure Levels for antimony (37 mg/kg), cadmium (77 mg/kg) and selenium (53 mg/kg). The Baseline Human Health Risk Assessment (BHHRA) demonstrated that excavation of the soils with concentrations of lead above the calculated Remedial Action Level (RAL) will result in a post-remediation cancer risk from arsenic ranging from 1×10^{-6} to 7×10^{-6} and a post remediation hazard quotient between 0.03 and 0.2.

The MNA Work Plan is organized as follows:

2.0 HYDROGEOLOGIC CONCEPTUAL SITE MODEL

2.1 PHYSICAL SETTING

The Site is located in the White River Drainage Basin. The Site is situated on a minor local topographic high with a surface elevation of approximately 845 feet above mean sea level (msl). The surface elevation slopes gently to the southeast toward Sloan Ditch, and the northwestern perimeter of the Site slopes to the northwest toward the intermittent headwaters of Beech Creek.

Surface water from the northern portion of the site flows to a drainage ditch along the CSX railroad tracks that eventually runs into an intermittent stream that flows northwest to the headwaters of Beech Creek. Surface water from the eastern and southern areas on the Site historically flowed to the south, eventually discharging to Sloan Ditch. Sloan Ditch flows 0.6 mile west-southwest to Churchman Creek, which flows to the west 0.9 mile and discharges to Beech Creek. Beech Creek flows 1.2 miles to the southwest to Lick Creek, which then flows 7 miles to the White River. Beginning in the early 1980s and continuing until May 2010 storm water runoff from the manufacturing areas of the site was collected, treated as required and discharged to the City of Indianapolis POTW. In the spring of 2010 (following site decontamination and demolition activities), RMC submitted a "No Exposure Certification", which included the results of post decontamination and demolition storm water sampling, for the storm water to IDEM and on May 7, 2010 received a determination that the site is no longer required to manage storm water runoff under IDEM Rule 6 (regarding storm water runoff from industrial activities). Since receipt of that determination, RMC has been discharging storm water collected from the former manufacturing areas into the drainage ditch that drains the northern portions of the site.

2.2 REGIONAL GEOLOGY AND HYDROGEOLOGY

The surficial geology of Marion County is glacial till (Tipton Till Plain) consisting of yellowish-gray, bluish-gray, or gray sand or silt with some clay and pebbles and scattered cobbles and boulders. The drift cover in Marion County is believed to be composed of three drift sheets resulting from the Kansan, Illinoian, and Wisconsin glaciations. Thickness of the glacial till in the region range from less than 15 feet to greater than 400 feet. The Site is underlain by approximately 200 feet of unconsolidated material. Bedrock is encountered at an elevation of approximately 640 feet mean sea level (on the order of 200 feet bgs), and consists of middle Devonian-aged dolomitic limestones. The limestones consist primarily of the Geneva Dolomite and the Jefferson Limestone. The Geneva Dolomite is a light gray to tan and buff to chocolate brown dolomite that contains white crystalline calcite masses. The Jeffersonville Limestone is a pure limestone in the upper portion of the formation, and is laminated with organic material in the lower portion. The organic laminae are more argillaceous than the coralline zone (Harrison, 1963). Meyer, 1975 indicates that shale is present beneath the glacial till and overlying the limestones. Additional detail on the shale unit is not provided by Meyer. The regional dip is to the southwest so that progressively younger formations are encountered below the till plain to the southwest.

Regionally, groundwater is encountered in un-named sand and gravel beds overlying the bedrock, the Jefferson Limestone and Geneva Dolomite, and the Niagaran Limestones (Harrison, 1963). The sand and gravel glacial outwash that coincides with the courses of the White River and Fall Creek is the aquifer of greatest economic importance in Marion County. The location of this aquifer generally coincides with the glacial melt water and outwash deposits along the major streams. Fall Creek enters White River upstream of the Site. The White River sand and gravel aquifer is located approximately 5.3 miles west of the Site.

It is noted by Meyer that three thin, aerially discontinuous, sheet-like deposits of sand and gravel in the till-plain area are separated by beds of silt and clay that cause the groundwater in these deposits to be semi-confined. Meyer also notes that large areas of silt and clay often separate one area of an aquifer from another. The elevation of the uppermost semi-confined aquifer beneath the Site was estimated to be approximately 720 ft msl (approximately 120 feet bgs) and is overlain by deposits of varying thickness of silt and clay, however; as discussed below the uppermost semi-confined aquifer was not encountered during site investigations activities which included boring to 130 feet deep. Groundwater flow in the uppermost regional semi-confined aquifer is reported to be towards the northwest. The middle regional semi-confined aquifer is not mapped beneath the Site because an aquitard (clay unit) is mapped in the area. The elevation of the lower regional semi-confined aquifer in the vicinity of the site is mapped at approximately 660 ft msl (180 ft bgs) with flow towards the southeast.

The average daily industrial and municipal groundwater pumpage for Marion County is 28.95 million gallons per day (mgpd). Less than 20 percent of the industrial/municipal pumpage is from the bedrock. Also, less than 20 percent of the total pumpage is obtained outside the unconfined glacial-outwash aquifer which occurs only along the White River and Fall Creek and is located at least 5.3 miles west of the Site. The major centers of groundwater pumpage occurred within approximately one mile of a major stream. The estimated total domestic groundwater pumpage is 9.0 to 11.0 mgpd (Meyer 1975).

2.3 SITE SPECIFIC GEOLOGY AND HYDROGEOLOGY

Based on results of the RFI activities, the surficial geology at the Site is consistent with the regional geology described in Section 2.2. Shallow surface conditions beneath portions of the Site have been altered as part of original facility construction and subsequent expansion activities. Several topographic high mounds in the wooded area northeast of the manufacturing area and adjacent to the intermittent stream/stormwater drainage ditch are believed to be fill material from on-site construction activities. Similarly, paved areas and areas below the structures on-site have been filled with gravel (i.e. subbase) at thicknesses ranging from 6 to 12 inches.

Four deep borings identified as MW-1D, MW-2D, MW-3D and MW-6D were advanced on-site to depths ranging from 110 feet to 130 feet bgs during the Phase I RFI to characterize subsurface conditions. Borings MW-2D and MW-6D were subsequently converted into monitoring wells as discussed below. The logs for these four deep borings are attached in Appendix A. The screened interval for MW-2D and MW-6D were set in a middle perched zone located 75 to 85 feet below grade. Stratigraphy typically varies from clayey silt to sandy silt, occasionally grading into clay or sand. When encountered, zones of clay or sand were generally thin and laterally discontinuous. The only notable exception was a clay layer encountered in all four deep borings that ranged in thickness from 7 to 12 feet at depths between 50 and 60 feet below ground surface (bgs). A second clay zone was encountered in each of the deep borings at depths typically between 90 and 100 bgs. The thickness of the till plain beneath the Site is at least 110 to 130 feet and the uppermost semi-confined regional aquifer was not encountered in any of the deep borings.

Shallow groundwater encountered at the Site represents a local perched zone of saturation in silty sand and sand layers within the glacial till. The four deep and seven shallow borings advanced during the RFI and CMS, and the five shallow boring logs advanced prior to installation of site monitoring wells MW-1 through MW-5 in 1991 (see Appendix A) indicate that the sand layers vary in thickness and elevation throughout the Site. The piezometric surface for the shallow on-site wells is represented by depth to groundwater measurements obtained during groundwater sampling performed on December, 2001 (Figure 1) and January, 2007 (Figure 2) and are similar to other sampling events. As shown, groundwater flow in the shallow on-site wells appears to be to the southeast beneath the former manufacturing areas (an area covered with buildings and pavement) and towards the east-northeast beneath the areas north of the former manufacturing area. The piezometric surface for the shallow perched groundwater on-site is less than 5 feet bgs and suggests a semi-confined or confined condition when compared against the higher permeability zones noted in the well boring logs. Southeast of the former manufacturing area, shallow groundwater flow heads south. The change in flow appears to be the result of greater amounts of infiltration occurring in the poorly drained grass areas between Arlington Avenue and the former manufacturing area. The area in the general vicinity of MW-11 will typically have standing water.

2.4 AQUIFER CHARACTERISTICS

Sieve analysis performed on shallow wells (MW-6SR, MW-8 and MW-9) installed during the Phase II RFI identified all samples analyzed as sandy silt or silt with sand (USCS Class ML). The vertical coefficient of permeability calculated from Triaxial Variable Head Permeability Test was 4.90×10^{-9} cm/sec from MW-6SR at 10-12 feet (above the screened interval) and 4.03×10^{-8} cm/sec for MW-6SR at 16-18 feet (within the screened interval). Undisturbed samples collected from MW-7 and MW-9 could not be analyzed for permeability because of material characteristics therefore sample analysis was limited grain size analysis. The grain-size distribution curves for the samples from MW-7 and MW-9 were very similar to the MW-6SR 16-18 foot sample and would be expected to have similar permeability.

Depth to groundwater measurements show a northwest to southeast gradient for the shallow perched zone beneath the manufacturing portions of the site ranging from <0.01 ft/ft to approximately 0.02 ft/ft. In the lawn area between the paved manufacturing area and South Arlington Avenue depth to groundwater measurements indicate a northeast to southwest gradient. As stated above, this is believed to be the result of greater amounts of infiltration occurring in the poorly drained lawn area. Where the northwest to southeast gradient beneath the paved manufacturing areas meets the northeast to southwest gradient from the lawn area, the shallow perched groundwater flow assumes a north to south flow direction.

Shallow groundwater conditions have been evaluated through the installation and sampling of twelve (12) shallow monitoring wells. Monitoring well locations are shown on Figures 1 and 2. Groundwater in the shallow zone of saturation beneath the former manufacturing area occurs as perched zones within thin, laterally discontinuous layers of sand and sandy silts contained in clayey-silt and silty-clay glacial deposits.

2.5 EXPOSURE PATHWAYS

Potable water in the vicinity of the Site is provided by a public water service; therefore, private use of the water beneath the Site is not an exposure pathway. The groundwater monitored by the MNA program is a perched zone located a few feet below the ground surface. This perched zone is limited in areal extent and does not provide flow rates sufficient enough for household or industrial use and is not used for the public water supply.

The perched zone beneath the Site discharges to adjacent swales during periods of high water table. This is a potential exposure pathway to surface water.

3.0 SUMMARY OF PREVIOUS GROUNDWATER SAMPLING

The results of groundwater sampling conducted as part of the RFI, Closure Investigation and CMS are provided in Tabular format on Tables 1A through 1L in the Corrective Measures Design Report. Field parameters for all wells are also provided in Tables 1A through 1L. Groundwater sampling performed as part of the RCRA Facility Investigation (RFI) and Closure Investigation have identified lead above 42 ug/L (IDEM Industrial Default RISC Criteria) in unfiltered groundwater samples on more than one occasion in groundwater monitoring wells MW-2 and MW-7. Investigation activities have identified arsenic above 10 ug/L (MCL and IDEM Industrial Default RISC Criteria) in filtered (i.e., dissolved) and unfiltered groundwater samples on more than one occasion in groundwater monitoring wells MW-1, MW-7 and MW-8, and on more than one occasion in only unfiltered samples in MW-2S, MW-3 and MW-10. A graphical presentation of filtered and unfiltered results for lead and arsenic for all the wells are presented on Figures 3A, 3B, 4A and 4C. Figure 2 provides isoconcentration lines for unfiltered lead and arsenic results for the January 2007 groundwater sampling event.

4.0 TECHNICAL BASIS FOR MONITORED NATURAL ATTENUATION

Results of the groundwater sampling did not reveal site-wide groundwater impacts; however, results did detect arsenic and lead above the screening levels utilized for this project in multiple samples from several wells. Therefore, USEPA has requested that shallow groundwater be included as a component of the Corrective Measures for the site and Monitored Natural Attenuation (MNA) has been selected as the remedy.

4.1 POTENTIAL SOURCE AREAS

4.1.1 Outdoor Feed Pile Storage Areas

As represented on Figures 1 and 2, the areas that lead exceeds the IDEM Industrial Default RISC Criteria and arsenic exceeds the MCL coincide with those areas of the site where the most intensive activities associated with the recycling operations occurred. Site operations consisted of recycling lead acid batteries to recover the lead. During the early operations (prior to 1984) battery breaking, the process used to separate the lead cores from the electrolyte (dilute sulfuric acid) and the casings, was conducted off-site and only the lead bearing components (grids, posts and oxide paste) were delivered to the site for smelting and refining. Materials received for processing were managed in piles prior to being fed into the furnace. The piles were situated on unpaved areas within the footprint of the Hazardous Waste Management Units (HWMUs) identified as the "Outdoor Waste Piles" or "Material Storage Building".

Beginning in 1984 and continuing until the end of facility operations in 1995, the site operated its own battery breaker, which included cutting or breaking open the batteries; separating the casings for off-site plastics recycling; collecting and neutralizing the acid prior to discharge to the POTW; and retaining the lead bearing components for smelting and refining. Facility improvements completed during the mid to late 1980s included paving site and eventually included the elimination of managing feed material outdoors.

Management of feed materials in outdoor piles is believed to be the most significant period of facility operations for impacting the shallow perched groundwater. The piles provided both a source for lead and arsenic and a mechanism capable of dissolving and transporting them into the subsurface (i.e., precipitation reacting with residual acid contained in the feed materials causing leaching).

4.1.2 Impacted Surface Materials

Sampling conducted in the area north of the battery breaker building and material storage building (representing outdoor waste piles 1 and 2 and containing MW-2, MW-7 and MW-8) identified fill materials with the highest concentrations of lead (up to 475,000 mg/kg) and arsenic (up to 2,730 mg/kg) on-site. These fill materials are believed to be a combination of residual amounts of the feed materials managed in the outdoor waste piles and filling performed as part of the grading required to internalize site storm water drainage.

Although with significantly lower concentrations of lead and arsenic relative to the area north of the battery breaker building, the unpaved area in vicinity of MW-1 was identified to contain shallow surface soils with lead up to 32,000 mg/kg and arsenic up to 359 mg/kg. These materials are believed to be the result of minor filling with contaminated soils. This area has been unpaved throughout the operating history of the facility and would have been susceptible to infiltrations that could potentially mobilize and infiltrate lead and/or arsenic.

4.2 PROPOSED SOURCE REMOVAL

The potential source areas for lead and arsenic impacts on groundwater are presented on Figures 1 and 2. Although not believed to be as significant a contributor as the outdoor waste pile area (because the area was under roof), we have also included the material storage building as a potential source area since lead bearing material was actively managed in this area and the floor was observed to be in poor condition at the time of facility closure. As shown on the Corrective Measures Design Drawings, the primary remedial activity will be the excavation of the most highly impacted soils at the site, including extensive excavation activities in the areas identified as potential source areas.

Based on a limited amount of SPLP Testing (USEPA Method 1312) conducted during the Corrective Measures Study, the average partitioning coefficients for lead and arsenic were 6,901 L/kg and 3,917 L/kg respectively. Utilizing these results and the IDEM Industrial Default RISC Criteria for arsenic and lead in groundwater in a Soil to Groundwater Partitioning Model with a ½ acre area (DAF = 20); the soil concentrations with the potential to cause unacceptable impact to groundwater are approximately 5,800 mg/kg lead and 780 mg/kg arsenic.

Following completion of soil remediation within the area in vicinity of MW-1, the average remaining lead and arsenic concentrations will be less than 800 mg/kg and 15 mg/kg, respectively. The locations of the former outdoor waste pile and material storage building areas will have even lower post remediation concentrations. Source removal, in the form of the proposed soil and sediment remediation activities is a critical component for realizing successful natural attenuation.

5.0 MNA DATA COLLECTION

5.1 GENERAL

Based on the results of previous groundwater sampling, the hydrogeologic conceptual site model, and an understanding of the operating history of the facility; the area of site groundwater that will be the subject of MNA has been delineated as shown on Figure 2. Monitoring activities will involve establishing a network of wells capable of providing information regarding the potentiometric surface and groundwater quality over time. A description of the proposed network and procedures for obtaining reliable information regarding groundwater elevations and representative analytical data is provided in the following sections.

The Sampling and Analysis Plan is provided as Appendix D of the Construction Quality Assurance Plan, and includes the Quality Assurance Project Plan components relative to groundwater sampling.

5.2 GROUNDWATER SAMPLING LOCATIONS

As described above, the shallow perched groundwater zone has been monitored using 12 monitoring wells installed between 1990 and 2005. To the extent practicable, the groundwater sampling locations to be utilized for MNA will rely on existing monitoring wells. Specifically, existing wells MW-1, MW-2, MW-3, MW-8, MW-9 and MW-12 will be utilized as part of the MNA sampling network. In addition, the proposed monitoring wells CC-1 through CC-6 will serve the dual purpose of monitoring the containment cell and being part of the MNA sampling network. Figure 2 presents the proposed groundwater monitoring network. These wells have been selected as they bound the MNA monitoring zone as depicted on Figure 2. Existing wells MW-7 and MW-10 are not included as part of the proposed MNA sampling network because they are located in the prepared containment cell location and are proposed for abandonment as part of the proposed corrective measures. Abandonment will be performed in accordance with the requirements of IDEM and Marion County Indiana. Well CC-6 will be installed at a location in the nearest downgradient location from the MW-7 and MW-10 locations which is outside the prepared containment cell footprint and will provide ample groundwater data for this area.

Proposed wells CC-1 through CC-6 will be installed during the corrective measures implementation after the containment cell berms and perimeter access roads have been constructed. During installation of CC-1 through CC-6, at least two (2) soil samples will be collected for chemical analysis from each boring. The data will be used for geochemical modeling, if needed. The one sample each will be collected from the unsaturated overburden soils and from within the proposed screen horizon in each boring utilizing split spoon sampling techniques. Soil samples will be submitted for laboratory pH and eH, target analyte list (TAL) metals, arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), total organic carbon and sulfate. Samples from the same depth/intervals will also be submitted for gradation (sieve and hydrometer analysis). Permeability testing will be performed in existing wells MW-1, MW-2, MW-8 and MW-9 and proposed wells CC-1, CC-3 and CC-6. Permeability testing shall be performed using slug tests (ASTM D4044 - 96(2008)).

5.3 WATER LEVEL MEASUREMENTS

At the start of each MNA groundwater sampling event, depth to water measurements will be obtained in general accordance with the American Society of Testing Materials (ASTM D 4750-97) procedures from all on-site wells. Depth to water measurements and date and time of measurement will be recorded to the nearest 0.01 ft in a bound field log book by the Technician performing the measurements. The total depth of the well will also be recorded (after the completion of groundwater sampling). At the time of gauging the field technician will also make any notations regarding the condition of the wells (including unsecured, broken or missing locks).

Depth to water level measurements will be taken from an established point at the top of the PVC riser pipe. Depth to water measurements will be obtained by carefully lowering an electronic water level indicator avoiding contact with the casing to the extent possible. The water level indicator probe will be decontaminated between each well. Additional information regarding the collection of water level measurements are included as part of the Sampling and Analysis Plan.

Results of the depth to groundwater level measurements will be used to develop a potentiometric groundwater contour map for the shallow perched groundwater. Addition of the proposed CC wells will also allow refinement of groundwater flow in the northern portions of the site.

5.4 MONITORED NATURAL ATTENUATION GROUNDWATER SAMPLING FREQUENCY

The MNA groundwater monitoring wells will be sampled beginning approximately one month following installation of the proposed containment cell monitoring wells. Sampling will be performed once every calendar quarter for twelve consecutive quarters with the first evaluation regarding future frequency performed after completion of the second year of monitoring (i.e., after 8 quarters). Monitoring will end when the sampling results demonstrate that the remedial goals have been attained for four consecutive quarters. If analysis after the first 12 consecutive quarters indicate increasing concentrations, RMC will continue quarterly sampling while evaluating the observed results and developing an alternate strategy for mitigating impacts. Monitoring wells will be added to the MNA monitoring well network as necessary if increasing concentrations are detected in the existing monitoring wells.

Sampling and analysis of containment cell groundwater monitoring wells will continue at the frequencies established in the Corrective Measures Design Report even after cessation of MNA groundwater monitoring.

5.5 GROUNDWATER ANALYTIC PARAMETER

During the first two quarterly groundwater sampling events, samples will be analyzed for total and dissolved arsenic and lead, sulfide, sulfate, nitrate arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), and manganese speciation (MnII/MnVII) for use in geochemical modeling. Beginning after the second quarterly groundwater sampling event, groundwater analysis will be limited to total and dissolved lead and arsenic. If subsequent sampling events identify sustained concentrations of lead and arsenic above the criteria established in the CMI Work Plan and previous modeling has established that MNA should be occurring, then additional sampling events for sulfide, sulfate, nitrate arsenic speciation (arsenite/arsenate), iron speciation (ferric/ferrous), and manganese speciation (MnII/MnVII) may be conducted as needed and the modeling re-evaluated.. Field parameter readings to be recorded at the time of sample collection during all groundwater sampling events shall include temperature; pH; Eh; dissolved oxygen (DO); specific conductance and turbidity.

6.0 DATA EVALUATION AND REPORTING

6.1 GENERAL

Monitored Natural Attenuation (MNA) of inorganic constituents like lead and arsenic in most settings is predominantly the result of sorption, precipitation, oxidation/reduction, advection, dispersion and/or diffusion. For the RMC site, initial information regarding the properties of the perched groundwater zone indicates low permeability soils (even within the saturated zones) and significant amounts of clay. Groundwater sampling has identified site wide near neutral pH conditions, neutral to slightly positive ORP (typically <100 mV). Based on these observations sorption is expected to be the dominant MNA process that can be anticipated going forward.

6.2 INITIAL DATA EVALUATION

Following completion of the second quarterly groundwater sampling event, potentiometric groundwater contour maps for the first two sampling events will be developed. The maps will be provided as a figure in an initial report that also presents and discusses the results of groundwater analysis. The report will be submitted to EPA and will provide an initial interpretation of the observed results for both groundwater and aquifer testing including geochemical physical characteristics. The results of the initial analysis will be utilized to perform computational speciation modeling using PHREEQC2 or similar program. Results of the modeling will be included with the initial data evaluation report. The RMC property boundaries will be considered the point of compliance with evaluating the data.

Trends analysis will not be performed until after 4 rounds of post-remediation groundwater sampling results have been obtained. A side by side comparison of observed total and dissolved lead and arsenic concentrations will be performed as part of the initial evaluation.

6.3 ANNUAL REPORTING AND TREND ANALYSIS

Results for arsenic and lead will be evaluated annually beginning after the collection of the fourth sampling event. Results will be initially evaluated against their corresponding action levels (lead 42 ug/L and arsenic 10 ug/L) to identify those wells with observed exceedances. For those groundwater monitoring wells where exceedances are observed, a subsequent evaluation will be performed using the Mann-Kendall (M-K) test to evaluate trends in the data on a well by well basis to determine if the plume is expanding (concentrations increasing), shrinking (concentrations decreasing), or stable. The M-K test is a non-parametric test used to evaluate trends in small data sets that are not normally or log-normally distributed. The test usually requires a minimum of four consecutive sets of data to provide representative results.

The M-K test will provide S-statistics for a comparison to a desired probability of 0.1 (α). A probability of 0.1 has been selected because it implies that there is only a 10% chance that random fluctuations would suggest a trend when a trend does not actually exist and is considered an acceptable Type I error. Given the desire to minimize the possibility of a Type II error (i.e. concluding that no trend exists, when one does exist), alpha = 0.1 is considered reasonable and appropriate given the absence of groundwater receptors at the site.

The annual report will include quarterly groundwater contour maps, additive results table (i.e. including all previous results beginning after the completion of the proposed Corrective Measures), the results of statistical analysis, and arsenic and lead isoconcentration maps over multiple time intervals. Evaluations of compliance will be performed relative to concentrations at the RMC property boundary.

DESIGN NARRATIVE
Replacement Pages